Agilent ESG Vector Signal Generator
User's Guide

Agilent Technologies

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User's Guide

Agilent Technologies
ESG Vector Signal Generator

This guide applies to signal generator models and associated serial number prefixes listed below. Depending on your firmware revision, signal generator operation may vary from descriptions in this guide.

E4438C: US4146

Part Number: E4400-90503

Printed in USA

April 2002

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1 Signal Generator Overview

Signal Generator Features

This section provides a list of standard signal generator features.

Standard Features:

- CW output from 250 kHz to 1, 2, 3, 4 or 6 GHz; the high-end frequency is dependent on the frequency option you purchased with your signal generator
- list and step sweep of frequency and amplitude, with multiple trigger sources
- external diode detector leveling
- user flatness correction
- automatic leveling control (ALC) on and off modes; power calibration in ALC-off mode is available, even without power search
- 10 MHz reference oscillator with external output
- GPIB, RS-232, and 10BASE-T LAN interfaces
- closed-loop AM
- dc-synthesized FM to 10 MHz rates; deviation depends on the carrier frequency
- phase modulation
- pulse modulation
- a dual function generator that includes the following features:
  - — 50Ω low frequency output, 0 to 3 V_p
  - — selectable waveforms: sine, square, positive ramp, negative ramp, triangle, gaussian noise, uniform noise, swept-sine, and dual-sine
  - — variable frequency modulation rates
  - — variable triggering in list and step sweep modes: auto, external, single, or remote
- a pulse generator that includes the following features:
  - — external pulse
  - — internal square wave
  - — selectable internal pulse modes: free-run, triggered (with delay), doublet, and gated; triggered (with delay), doublet, and gated require an external trigger source

  - — adjustable pulse width
  - — adjustable pulse period
  - — adjustable pulse delay
- external modulation inputs for AM, FM, and ΦM
- simultaneous modulation configurations

Options

Tables 1-1 through 1-7 show the available options for your signal generator. They include hardware, personalities, frequency options, service options, system accessories, and documentation.

Table 1-1 Hardware Options

Option	Description
001	Internal baseband generator with 8 Msample memory
002	Internal baseband generator with 32 Msample memory
005	6-GByte hard drive (Option 001 or 002 required)
1E5	High-stability time base
1EM	Moves front panel connectors to rear panel
300	GSM/EDGE base station loopback BER test capability (requires Options UN7, 001 or 002, 402)
UN7	Internal bit-error-rate analyzer
UNB	High output power with mechanical attenuator
UNJ	Enhanced phase noise performance (includes Option 1E5)

Table 1-2 Signal Generation Personalities

Option	Description
400	3GPP W-CDMA (Option 001 or 002 required)
401	cdma2000 and IS95A CDMA (Option 001 or 002 required)
402	TDMA (includes GSM, EDGE, NADC, PDC, PHS, TETRA, and DECT; Option 001 or 002 required)
403	Calibrated noise (Option 001 or 002 required)

Table 1-3 Software Personalities

Option	Description
404	cdma2000 1xEV-DO Signal Studio software (Option 001 or 002 and a PC required)
405	Wireless LAN (802.11b) Signal Studio software (Option 001 or 002 and a PC required)
406	Bluetooth™ Signal Studio software (Option 001 or 002 and a PC required)
410	Wireless LAN (802.11a) Signal Studio software (Option 001 or 002 and a PC required)

NOTE To ensure an up-to-date list of available software personalities, refer to **www.agilent.com/find/signalstudio.**

Table 1-4 Frequency Options

Option	Description
501	250 kHz to 1 GHz frequency range
502	250 kHz to 2 GHz frequency range
503	250 kHz to 3 GHz frequency range
504	250 kHz to 4 GHz frequency range
506	250 kHz to 6 GHz frequency range (requires Option UNJ)

Table 1-5 System Accessories

Option	Description
1CN	Front handle kit
1CP	Rack mount kit with handles

Table 1-6 Documentation

Option	Description
0BV	Service documentation (component level)
0BW	Service documentation (assembly level)
ABA	Printed documentation set (English language)
CD1	Documentation/IntuiLink CD-ROM set

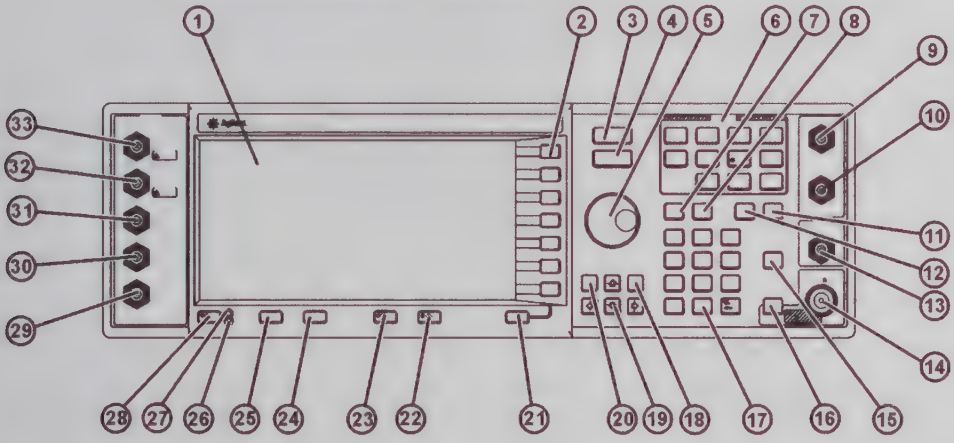
Table 1-7 Service Options

Option	Description
UK6	Commercial calibration certificate with test data

Front Panel Overview

Figure 1-1 shows the signal generator front panel. This interface enables you to define, monitor, and manage input and output characteristics.

Figure 1-1 Front Panel Feature Overview



1. Display

The LCD screen provides information on the current function. Information can include status indicators, frequency and amplitude settings, and error messages. Labels for the softkeys are located on the right-hand side of the display. For further description of the front panel display, refer to "Front Panel Display" on page 14.

2. Softkeys

Softkeys activate the function indicated by the displayed label to the left of each key.

3. Frequency Key

Pressing this hardkey makes frequency the active function. You can change the RF output frequency or use the menus to configure frequency attributes such as frequency multiplier, offset, and reference.

4. Amplitude Key

Pressing this hardkey activates the amplitude function. You can change the RF output amplitude or use the menus to configure amplitude attributes such as power search, user flatness, and leveling mode.

5. Knob

Rotating the knob increases or decreases a numeric value or changes a highlighted digit or character. You can also use the knob to step through lists or select items in a row.

6. Menu Keys

These hardkeys access softkey menus enabling configuration of list and step sweeps, utility functions, the LF output, and various analog modulation types. For detailed information on these keys, refer to the *Key and Data Field Reference*.

7. Save Key

This hardkey accesses a menu of softkeys enabling you to save data in the instrument state register. The instrument state register is a section of memory divided into 10 sequences numbered 0 through 9. Each sequence contains 100 registers numbered 00 through 99. **Save** allows you to store and recall frequency and amplitude settings. It provides a quick alternative to reconfiguring the signal generator via the front panel or SCPI commands when switching between different signal configurations. Once an instrument state has been saved, all of the frequency, amplitude, and modulation settings can be recalled with the **Recall** hardkey.

8. Recall Key

This hardkey restores any instrument state that you previously saved in a memory register.

9. EXT 1 INPUT

This BNC input connector accepts a ±1 V_p signal for AM, FM, and ΦM. For all these modulations, ±1 V_p produces the indicated deviation or depth. When ac-coupled inputs are selected for AM, FM, or ΦM and the peak input voltage differs from 1 V_p by more than 3%, the HI/LO annunciators light on the display. The damage levels are 5 V_{rms} and 10 V_p.

This connector can also serve as burst envelope input providing linear control as follows: 0 V = 100% amplitude, –1.00 V = 0% amplitude.

If you configure your signal generator with Option 1EM, this input is relocated to a female BNC connector on the rear panel.

10. EXT 2 INPUT

This BNC input connector accepts a ±1 V_p signal for AM, FM, ΦM, and pulse modulation. With AM, FM, or ΦM, ±1 V_p produces the indicated deviation or depth. With pulse modulation, +1 V is on and 0 V is off.

When ac-coupled inputs are selected for AM, FM, or ΦM and the peak input voltage differs from 1 V_p by more than 3%, the HI/LO annunciators light on the display. The damage levels are 5 V_{rms} and 10 V_p.

If you configure your signal generator with Option 1EM, this input is relocated to a female BNC connector on the rear panel.

11. Help Key

Press this hardkey to view a short description of any hardkey or softkey. There are two help modes available on the signal generator; single and continuous. Single mode is the factory preset condition.

Toggle between single and continuous mode by pressing **Utility** > **Instrument Info/Help Mode** > **Help Mode Single Cont**.

- When you press the **Help** key in single mode, help text is provided for the next key you press without activating the key's function. Any key pressed afterward exits the help mode and activates the key's function.
- When you press the **Help** key in continuous mode, help text is provided for each subsequent key press until you press the **Help** key again or change to single mode. In continuous mode, pressing the **Help** key also activates the key's function (except for the **Preset** key).

12. Trigger Key

This hardkey initiates an immediate trigger event for a function such as a list or step sweep. The trigger mode must be set to **Trigger Key** prior to initiating a trigger event with this hardkey.

13. LF OUTPUT

This BNC connector is the output for modulation signals generated by the low frequency (LF) source function generator. This output is capable of driving 3 V_p (nominal) into a 50Ω load.

If you configure your signal generator with Option 1EM, this output is relocated to a female BNC connector on the rear panel.

14. RF OUTPUT

This female Type-N connector is the output for RF signals. The source impedance is 50Ω The damage levels are 50 Vdc, 50 W at ≤ 2 GHz, and 25 W at > 2 GHz maximum. The reverse power protection circuit will trip, however, at nominally 1 W.

If you configure your signal generator with Option 1EM, this output is relocated to a female Type-N connector on the rear panel.

15. Mod On/Off Key

This hardkey toggles the operating state of all modulation signals. Although you can set up and enable various modulation states, the RF carrier is not modulated until **Mod On/Off** is set to On. An annunciator is always present in the display to indicate whether modulation is turned on or off.

16. RF On/Off Key

This hardkey toggles the operating state of the RF signal present at the RF OUTPUT connector. An annunciator is always visible in the display to indicate whether the RF is turned on or off.

17. Numeric Keypad

The numeric keypad consists of the 0 through 9 hardkeys, a decimal point hardkey, and a backspace hardkey ([+/-←]). The backspace hardkey enables you to backspace or specify a negative value. When specifying a negative numeric value, the negative sign must be entered prior to entering the numeric value.

18. Incr Set Key

This hardkey enables you to set the increment value of the current active function. When this hardkey is pressed, the increment value of the current active function will appear in the active entry area of the display. Use the numeric keypad, arrow hardkeys, or the knob to adjust the increment value.

19. Arrow Keys

The up and down arrow hardkeys are used to increase or decrease a numeric value, step through displayed lists, or select items in a row of a displayed list. Individual digits or characters may be highlighted using the left and right arrow hardkeys. Once an individual digit or character is highlighted, its value can be changed using the up and down arrow hardkeys.

20. Hold Key

This hardkey blanks the softkey label area and text areas on the display. Softkeys, arrow hardkeys, the knob, the numeric keypad, and the **Incr Set** hardkey have no effect once this hardkey is pressed.

21. Return Key

This hardkey enables you to retrace your key presses. When in a menu with more than one level (More 1 of 3, More 2 of 3, etc.), the **Return** key will always return you to the first level of the menu.

22. Display Contrast Increase Key

This hardkey, when pressed or held, causes the display background to lighten.

23. Display Contrast Decrease Key

This hardkey, when pressed or held, causes the display background to darken.

24. Local Key

This hardkey is used to deactivate remote operation and return the signal generator to front panel control.

25. Preset Key

This hardkey is used to set the signal generator to a known state (factory or user-defined).

26. Standby LED

This yellow LED indicates when the signal generator power switch is set to the standby condition.

27. Line Power LED

This green LED indicates when the signal generator power switch is set to the on position.

28. Power Switch

This switch activates full power to the signal generator when set to the on position, and deactivates all signal generator functions when in standby mode. In standby mode, the signal generator remains connected to the line power and power is supplied to some internal circuits.

29. SYMBOL SYNC (Input Connector)

The CMOS compatible SYMBOL SYNC connector accepts an externally supplied symbol sync for digital modulation applications. The expected input is a TTL or CMOS bit clock signal. It may be used in two modes. When used as a symbol sync in conjunction with a data clock, the signal must be high during the first data bit of the symbol. The signal must be valid during the falling edge of the data clock signal and may be a single pulse or continuous. When the SYMBOL SYNC itself is used as the (symbol) clock, the CMOS falling edge is used to clock the DATA signal.

The maximum clock rate is 50 MHz. The damage levels are > +8 and < –4 V.

This female BNC connector is provided on signal generators with Option 001 or 002. On signal generators with Option 1EM, this input is relocated to a rear panel SMB connector.

When using the real-time W-CDMA uplink personality, this connector should *not* be used to connect the external baseband generator data clock. The BASEBAND GEN REF IN connector should be used instead.

30. DATA CLOCK (Input Connector)

The TTL/CMOS compatible DATA CLOCK connector accepts an externally supplied data-clock input for digital modulation applications. The expected input is a TTL or CMOS bit clock signal where the rising edge is aligned with the beginning data bit. The falling edge is used to clock the DATA and SYMBOL SYNC signals.

The maximum clock rate is 50 MHz. The damage levels are > +8 and < –4 V.

This female BNC connector is provided on signal generators with Option 001 or 002. On signal generators with Option 1EM, this input is relocated to a rear panel SMB connector.

31. DATA (Input Connector)

The TTL/CMOS compatible DATA connector accepts an externally supplied data input for digital modulation applications. The expected input is a TTL or CMOS signal where a CMOS

high is equivalent to a data 1 and a CMOS low is equivalent to a data 0.

The maximum input data rate is 50 Mb/s.The data must be valid on the DATA CLOCK falling edges. The damage levels are > +8 and < –4 V.

This female BNC connector is provided on signal generators with Option 001 or 002. On signal generators with Option 1EM, this input is relocated to a rear panel SMB connector.

32. Q (Input Connector)

This connector accepts an externally supplied, analog, quadrature-phase component of I/Q modulation. The signal level is $\sqrt{I^2+Q^2}$ = 0.5 V_{rms} for a calibrated output level. The input impedance is 50Ω. The damage level is 1 V_{rms}.

If you configure your signal generator with Option 1EM, this input is relocated to the rear panel.

33. I (Input Connector)

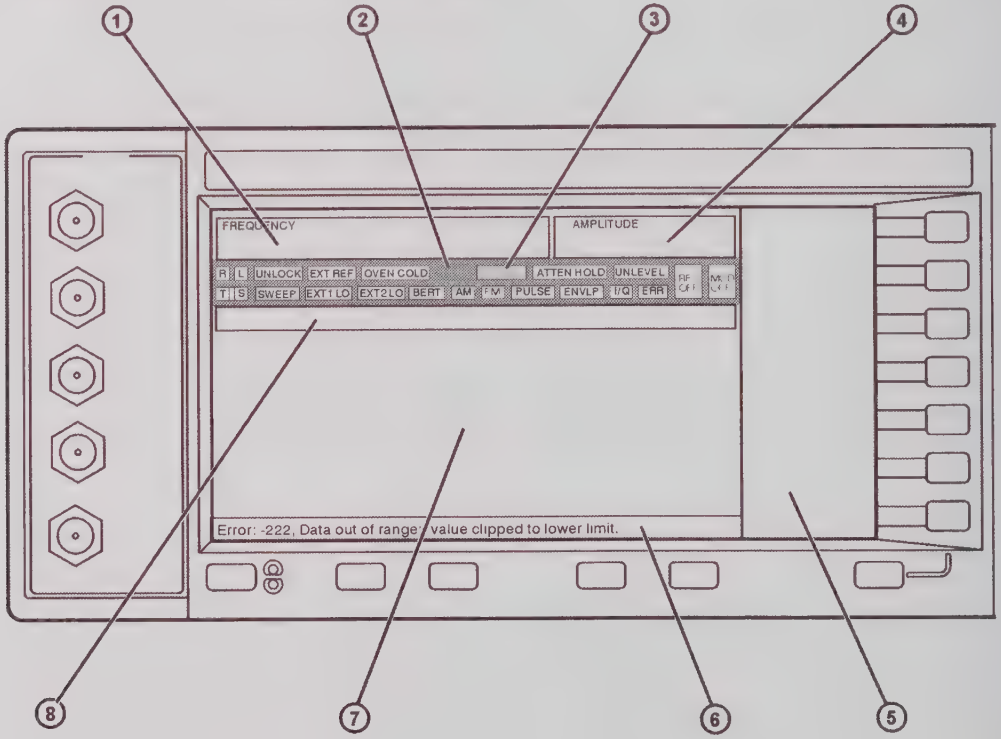
This connector accepts an externally supplied, analog, in-phase component of I/Q modulation. The signal level is $\sqrt{I^2+Q^2}$ = 0.5 V_{rms} for a calibrated output level. The input impedance is 50Ω. The damage level is 1 V_{rms}.

If you configure your signal generator with Option 1EM, this input is relocated to the rear panel.

Front Panel Display

Figure 1-2 shows the front panel display. The LCD screen will display data fields, annotations, key press results, softkey labels, error messages, and annunciators that represent various active functions of the signal generator. Descriptions are provided for each feature of this interface.

Figure 1-2 Front Panel Display



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1. Frequency Area

The current frequency setting is shown in this portion of the display. Indicators are also displayed in this area when the frequency offset or multiplier is used, the frequency reference mode is turned on, or an external frequency is used.

2. Annunciators

The display annunciators show the status of some of the signal generator functions, and indicate error conditions. An annunciator position may be used by more than one function. This does not create a problem, because only one function that shares an annunciator position can be active at a given time.

ΦM	This annunciator appears when phase modulation is turned on. If frequency modulation is turned on, the FM annunciator will replace ΦM.
ALC OFF	This annunciator appears when the ALC circuit is disabled. A second annunciator, UNLEVEL, will appear in the same position if the ALC is enabled and is unable to maintain the output level.
AM	This annunciator appears when amplitude modulation is turned on.
ARMED	This annunciator appears when a sweep has been initiated and the signal generator is waiting for the sweep trigger event.
ATTEN HOLD	This annunciator appears when the attenuator hold function is turned on. When this function is on, the attenuator is held at its current setting.
BERT	This annunciator appears when the Option UN7 bit error rate test (BERT) functions are turned on.
ENVLP	This annunciator appears if the burst envelope modulation is turned on.
ERR	This annunciator appears when an error message is placed in the error queue. This annunciator will not turn off until you have viewed all of the error messages or cleared the error queue. You can access error messages by pressing **Utility > Error Info**.
EXT	This annunciator appears when external leveling is turned on.
EXT1 LO/HI	This annunciator is displayed as either EXT1 LO or EXT1 HI. This annunciator appears when the ac-coupled signal to the EXT 1 INPUT is less than 0.97 V_p or greater than 1.03 V_p.
EXT2 LO/HI	This annunciator is displayed as either EXT2 LO or EXT2 HI. This annunciator appears when the ac-coupled signal to the EXT 2 INPUT is less than 0.97 V_p or greater than 1.03 V_p.
EXT REF	This annunciator appears when an external frequency reference is applied.
FM	This annunciator appears when frequency modulation is turned on. If phase modulation is turned on, the ΦM annunciator will replace FM.

L	This annunciator appears when the signal generator is in listener mode and is receiving information or commands over the GPIB, RS-232, or VXI-11 (LAN) interface.
MOD ON/OFF	This annunciator indicates if the RF carrier is modulated (MOD ON), or if the modulation is off (MOD OFF). Either condition of this annunciator is always visible in the display.
OVEN COLD	This annunciator appears when the temperature of the internal oven reference oscillator has dropped below an acceptable level. When this annunciator is on, frequency accuracy is degraded. This condition should occur only if the signal generator is disconnected from line power. The annunciator is timed, and automatically turns off after a specified period.
PULSE	This annunciator appears when pulse modulation is turned on.
R	This annunciator appears when the signal generator is remotely controlled over the GPIB, RS-232, or VXI-11/Sockets (LAN) interface.
RF ON/OFF	This annunciator indicates when the RF signal is present (RF ON) at the RF OUTPUT, or if the RF signal is not present (RF OFF) at the RF OUTPUT. Either condition of this annunciator is always visible in the display.
S	This annunciator appears when the signal generator has generated a service request (SRQ) over the GPIB, RS-232, or VXI-11 (LAN) interface.
SWEEP	This annunciator appears when the signal generator is sweeping in list or step mode.
T	This annunciator appears when the signal generator is in talker mode and is transmitting information over the GPIB, RS-232, or VXI-11 (LAN) interface.
UNLEVEL	This annunciator appears when the signal generator is unable to maintain the correct output level. The UNLEVEL annunciator is not necessarily an indication of instrument failure. Unleveled conditions can occur during normal operation. A second annunciator, ALC OFF, will appear in the same position when the ALC circuit is disabled.
UNLOCK	This annunciator appears when any of the phase locked loops are unable to maintain phase lock. You can determine which loop is unlocked by examining the error messages.

3. Digital Modulation Annunciators

All digital modulation annunciators appear in this location. These annunciators appear only when the modulation is active, and only one digital modulation can be active at any given

time.

4. Amplitude Area

The current output power level setting is shown in this portion of the display. Indicators are also displayed in this area when amplitude offset is used, amplitude reference mode is turned on, external leveling mode is enabled, and when user flatness is enabled.

5. Softkey Label Area

The labels in this area define the function of the softkeys located immediately to the right of the label. The softkey label will change depending upon the function selected. For detailed softkey descriptions, refer to the *Key and Data Field Reference*.

6. Error Message Area

Abbreviated error messages are reported in this space. When multiple error messages occur, only the most recent message remains displayed. Reported error messages with details can be viewed by pressing **Utility** > **Error Info**.

7. Text Area

This area of the display is used to show status information about the signal generator such as the modulation status, sweep lists, and file catalogs. This area also enables you to perform functions such as managing information, entering information, and displaying or deleting files.

8. Active Function Area

The current active function is shown in this area. For example, if frequency is the active function, the current frequency setting will be displayed here. If the current active function has an increment value associated with it, that value is also displayed.

Rear Panel Overview

Figure 1-3 shows the signal generator rear panel. The signal generator rear panel provides input, output, and remote interface connections. Descriptions are provided for each rear panel connector.

Figure 1-3 Rear Panel Feature Overview

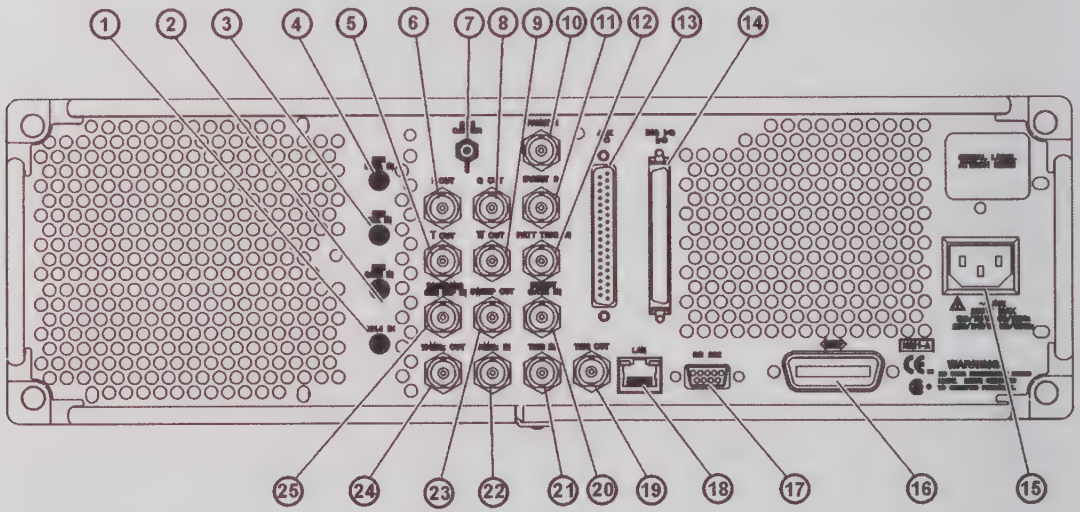

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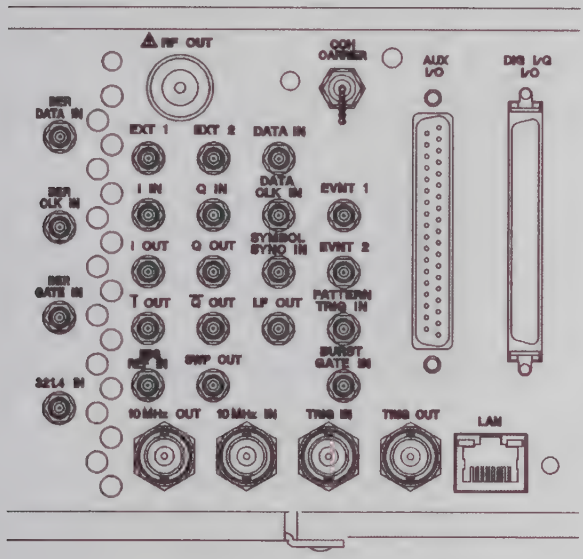
Figure 1-4 shows a portion of the rear panel for signal generators with Option 1EM only. Option 1EM moves the front panel connectors to the rear panel. For rear panel connector descriptions for Option 1EM that are not included in this section, refer to "Front Panel Overview" on page 7.

Figure 1-4



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1. 321.4 IN Connector (Option 300 only)

Use this female SMB connector to input a down converted 321.4 MHz GSM/EDGE signal for base transceiver station (BTS) loopback measurements. (Option 300 also requires Options UN7, 001 or 002, and 402).

2. BER GATE IN Connector (Option UN7 only)

Use this connector to input the clock gate signal for the bit-error-rate measurements. The clock signal to the BER CLK IN connector is valid only when the signal to this connector is a high or low, depending on your softkey selection or SCPI command. The damage levels are > +8 and < –4 V. This connector must be terminated with a TTL-compatible high impedance or 75Ω load. This connector can be enabled or disabled by a softkey or a SCPI command.

3. BER CLK IN Connector (Option UN7 only)

Use this connector to input the clock signal for the bit-error-rate measurements. The rising (positive) or falling (negative) edge of the signal (selected either by softkey or SCPI command) causes data on the BER DATA IN connector to be sampled. The damage levels are > +8 and < –4 V. This connector must be terminated with a TTL-compatible high impedance or 75Ω load.

4. BER DATA IN Connector (Option UN7 only)

Use this connector to input the data streams for the bit-error-rate measurements. The rising (positive) or falling (negative) edge of the BER CLK IN signal (selected by the softkey or the SCPI command) is used to trigger the reading of the data. The damage levels are > +8 and < –4 V. This connector must be terminated with a TTL-compatible high impedance or 75Ω load.

5. I-bar OUT Connector

I-bar is used in conjunction with I to provide a balanced baseband stimulus. Balanced signals are signals present in two separate conductors that are symmetrical relative to ground, and are opposite in polarity (180 degrees out of phase). The nominal output impedance of this connector is 50Ω, DC-coupled. The damage levels are > +2 V and < –2 V. The DC origin offset is typically < 10 mV. The output signal levels into a 50Ω load are as follows:

- 0.5 V_{pk}, typical, corresponds to one unit length of the I/Q vector.
- 0.69 V_{pk} (2.84 dB), typical, maximum crest factor for peaks for π/4 DQPSK with alpha = 0.5.
- 0.71 V_{pk} (3.08 dB), typical, maximum crest factor for peaks for π/4 DQPSK with alpha = 0.35.
- Typically 1 V_{p-p} maximum (Option 001 or 002 only).

This female BNC connector is provided only on signal generators with Option 001 or 002. If you configure your signal generator with Option 1EM, this output is relocated from a BNC to an SMB connector.

6. I OUT Connector

The I OUT connector outputs the analog, in-phase component of I/Q modulation from the internal baseband generator. The nominal output impedance of this connector is 50Ω, DC-coupled. The damage levels are > +2 V and < –2 V. The DC origin offset is typically < 10 mV. The output signal levels into a 50Ω load are as follows:

- 0.5 V_{pk}, typical, corresponds to one unit length of the I/Q vector.
- 0.69 V_{pk} (2.84 dB), typical, maximum crest factor for peaks for π/4 DQPSK with alpha = 0.5.
- 0.71 V_{pk} (3.08 dB), typical, maximum crest factor for peaks for π/4 DQPSK with alpha = 0.35.
- Typically 1 V_{p-p} maximum (Option 001 or 002 only).

This female BNC connector is provided only on signal generators with Option 001 or 002. If you configure your signal generator with Option 1EM, this output is relocated from a BNC to an SMB connector.

7. COH CARRIER Output Connector

The coherent carrier connector outputs RF that is not modulated with AM, pulse, or I/Q modulation, but is modulated with FM or ΦM. The output power is nominally –2 dBm ±5 dB. The output frequency range is from 249.99900001 MHz to the maximum specified frequency of your signal generator. If the RF output frequency is below this range, the coherent carrier output signal will have the following frequency: Frequency of coherent carrier = (1E9 – Frequency of RF output) in Hz. The damage levels are 20 Vdc and 13 dBm reverse RF power.

8. Q OUT Connector

The Q OUT connector outputs the analog, quadrature-phase component of I/Q modulation from the internal baseband generator. The nominal output impedance of this connector is 50Ω, DC-coupled. The damage levels are > +2 V and < –2 V. The DC origin offset is typically < 10 mV. The output signal levels into a 50Ω load are as follows:

- 0.5 V_{pk}, typical, corresponds to one unit length of the I/Q vector.
- 0.69 V_{pk} (2.84 dB), typical, maximum crest factor for peaks for π/4 DQPSK with alpha = 0.5.
- 0.71 V_{pk} (3.08 dB), typical, maximum crest factor for peaks for π/4 DQPSK with alpha = 0.35.
- Typically 1 V_{p-p} maximum (Option 001 or 002 only).

This female BNC connector is provided only on signal generators with Option 001 or 002. If you configure your signal generator with Option 1EM, this output is relocated from a BNC to an SMB connector.

9. Q-bar OUT Connector

Q-bar is used in conjunction with Q to provide a balanced baseband stimulus. Balanced signals are signals present in two separate conductors that are symmetrical relative to ground, and are opposite in polarity (180 degrees out of phase). The nominal output impedance of this connector is 50Ω, DC-coupled. The damage levels are > +2 V and < –2 V. The DC origin offset is typically < 10 mV. The output signal levels into a 50Ω load are as follows:

- 0.5 V_{pk}, typical, corresponds to one unit length of the I/Q vector.
- 0.69 V_{pk} (2.84 dB), typical, maximum crest factor for peaks for π/4 DQPSK with alpha = 0.5.
- 0.71 V_{pk} (3.08 dB), typical, maximum crest factor for peaks for π/4 DQPSK with alpha = 0.35.
- Typically 1 V_{p-p} maximum (Option 001 or 002 only).

This female BNC connector is provided only on signal generators with Option 001 or 002. If you configure your signal generator with Option 1EM, this output is relocated from a BNC to an SMB connector.

10. EVENT 1 Connector

With Option 001 or 002 installed, this connector outputs a pulse that can be used to trigger the start of a data pattern, frame, or timeslot. It is adjustable to within plus or minus one timeslot with one bit of resolution. With Option 401 installed (Option 401 requires Option 001 or 002 hardware), an even second output is generated. A marker is output every two seconds indicating the beginning of each short code sequence for use in synchronizing CDMA analysis instruments.

With Option 001 or 002 installed, there is a marker on/off condition associated with each waveform point. A marker (3.3 V CMOS high when positive polarity is selected; 3.3 V CMOS low when negative polarity is selected) is output on the EVENT 1 connector whenever a Marker 1 is turned on in the waveform. (Markers are automatically turned on whenever you set them in a waveform segment. When you combine waveform segments that contain Marker 1 into a sequence, the markers are automatically turned off until you toggle them on in either the Edit Selected Waveform Sequence menu or in the Build New Waveform Sequence menu.)

The damage levels for this connector are > +8 V and < –4 V. This female BNC connector is provided only on instruments with Option 001 or 002. If you configure your signal generator with Option 1EM, this output is changed from a BNC to an SMB connector. With Option 401 you can select from several different output signals for this connector.

11. EVENT 2 Connector

With Option 001 or 002 installed, this connector outputs a data enable signal for gating external equipment. The output is applicable when the external data is clocked into internally generated timeslots. Data is enabled when the signal is low. With Option 401 installed (Option 401 requires Option 001 or 002 hardware), a marker is output on the EVENT 2 connector every 26.67 milliseconds, corresponding to the start of each short code.

With Option 001 or 002 installed, there is a marker on/off condition associated with each waveform point. A marker (3.3 V CMOS high when positive polarity is selected; 3.3 V CMOS low when negative polarity is selected) is output on the EVENT 2 connector whenever a Marker 2 is turned on in the waveform. (Markers are automatically turned on whenever you set them in a waveform segment. When you combine waveform segments that contain Marker 2 into a sequence, the markers are automatically turned off until you toggle them on in either the Edit Selected Waveform Sequence menu or in the Build New Waveform Sequence menu.)

The damage levels are > +8 V and < –4 V. This female BNC connector is provided only on signal generators with Option 001 or 002. On signal generators with Option 1EM, this output is changed from a BNC to an SMB connector. With Option 401 this connector is used for system reset output.

12. PATT TRIG IN Connector

This input can accept either a TTL/CMOS low to TTL/CMOS high or TTL/CMOS high to TTL/CMOS low edge trigger. The minimum trigger input pulse width, high or low, is 100 ns. The damage levels are > +8 and < –4 V. This female BNC connector is provided only on signal generators with Option 001 or 002. If you configure your signal generator with Option 1EM, this input is changed from a BNC to an SMB connector.

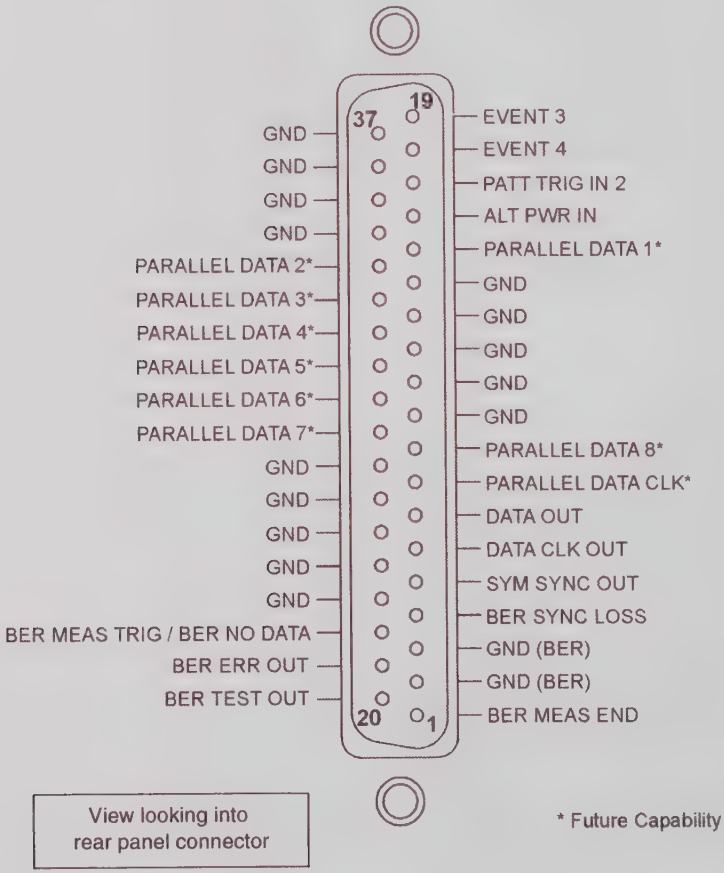
With Option 001 and 002 installed, the input to the PATT TRIG IN connector is used to trigger the internal digital modulation pattern generator to start a single pattern output or to stop and re-synchronize a pattern that is being continuously output. The trigger edge is latched and then sampled by the falling edge of the internal data bit clock to synchronize the trigger with the data bit clock timing. The minimum delay from the trigger edge to the first bit of the frame is 1.5 to 2.5 bit clock periods.

With Option 001 or 002 installed, this connector is the source for the external trigger for all of the ARB waveform generator triggers. With Option 401 this connector is used for system reset trigger input.

13. AUX I/O Connector

This connector enables you to access the inputs and outputs of the baseband generator. Figure 1-5 shows the AUX I/O pin connector configuration.

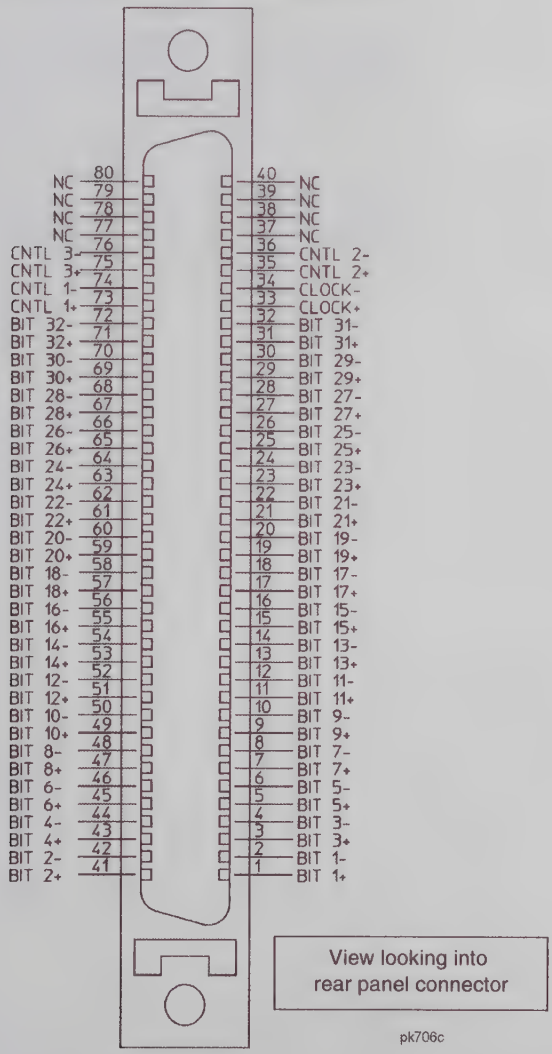
Figure 1-5 AUX I/O pin configuration



14. DIG I/Q I/O Connector

Figure 1-6 shows the DIG I/Q I/O pin connector configuration. This connector is inactive, but will be available at a future signal generator release.

Figure 1-6 DIG I/Q I/O pin configuration



15. AC Power Receptacle

The power cord receptacle accepts a three-pronged cable that is shipped with the signal generator. The line voltage is connected here.

16. GPIB Connector

The GPIB connector allows communications with compatible devices such as external controllers. It is functionally equivalent to the LAN and RS 232 connectors.

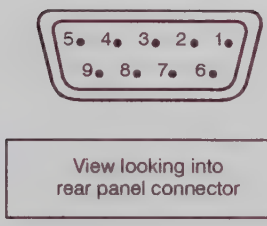
17. RS 232 Connector

This male DB-9 connector is an RS-232 serial port that can be used for controlling the signal generator remotely. It is functionally equivalent to the GPIB and LAN connectors. The following table shows the description of the pinouts. Figure 1-7 on page 27 shows the pin configuration.

Table 1-8 RS 232 Connector

Pin Number	Signal Description	Signal Name
1	No Connection	
2	Receive Data	RECV
3	Transmit Data	XMIT
4	+5 V	
5	Ground, 0 V	
6	No Connection	
7	Request to Send	RTS
8	Clear to Send	CTS
9	No Connection	

Figure 1-7



18. LAN Connector

LAN based communication is supported by the signal generator via the LAN (local area network) connector. The LAN connector enables the signal generator to be remotely programmed by a LAN-connected computer. The distance between a computer and the signal generator is limited to 100 meters (10BASE-T). For more information about the LAN, refer to the Getting Started chapter in the *Programming Guide*.

19. TRIG OUT Connector

This female BNC connector outputs a TTL signal that is asserted high at the start of a dwell sequence, or at the start of waiting for the point trigger in manual sweep mode. It is asserted low when the dwell is over, when the point trigger is received, or once per sweep during an LF sweep. The logic polarity can be reversed.

20. BURST GATE IN Connector

The BURST GATE IN connector accepts a TTL or CMOS signal for gating burst power in digital modulation applications. The burst gating is used when you are externally supplying data and clock information. The input signal must be synchronized with the external data input that will be output during the burst. The burst power envelope and modulated data are internally delayed and re-synchronized. The input signal must be CMOS high for normal burst RF power or CW RF output power and CMOS low for RF off. The leading edges must be synchronous with the DATA CLOCK rising edges. The damage levels are > +8 and < –4 V.

This female BNC connector is provided only on signal generators with Option 001 or 002. If you configure your signal generator with Option 1EM, this output is changed from a BNC to an SMB connector. With Option 401, this connector is used for even second synchronization input.

21. TRIG IN Connector

This female BNC connector accepts a TTL or CMOS signal for triggering operations, such as point-to-point in manual sweep mode or an LF sweep in external sweep mode. Triggering can occur on either the positive or negative edge. The damage level is ≥ +10 V or ≤ –4 V.

22. 10 MHz IN Connector

This female BNC connector accepts a –3.5 to +20 dBm signal from an external timebase reference that is within ±10 ppm (standard timebase) or ±1 ppm (high stability timebase). The nominal input impedance is 50Ω The signal generator detects when a valid reference signal is present at this connector and automatically switches from internal to external reference operation.

23. SWEEP OUT Connector

This female BNC connector provides a voltage range of 0 to +10 V. When the signal generator is sweeping, the SWEEP OUT signal ranges from 0 V at the beginning of the sweep to +10 V at the end of the sweep regardless of the sweep width. In CW mode this connector has no output. The output impedance is less than 1Ω and can drive 2 kΩ.

24. 10 MHz OUT Connector

This female BNC connector provides a nominal signal level of +3.9 dBm ±2 dB, and an output impedance of 50Ω The accuracy is determined by the timebase used.

25. BASEBAND GEN REF IN Connector

With Option 001 and 002 installed, the BASEBAND GEN REF IN connector accepts a 0 to +20 dBm sine wave or TTL square wave signal from an external timebase reference. This digital modulation reference clock is used by the internal baseband generator for both component and receiver test applications (only the *internal* baseband generator can be locked to this external reference; the RF frequency remains locked to the 10 MHz reference). The nominal input impedance is 50Ω at 13 MHz, AC-coupled.

With Option 001 or 002 installed, this connector accepts a TTL or > –10 dBm sine wave external reference at rates from 250 kHz through 100 MHz. The internal clock for the arbitrary waveform generator is locked to this signal when external reference is selected in the ARB setup. The minimum pulse width must be > 10 ns. The damage levels are > +8 V and < –8 V.

This female BNC connector is provided only on signal generators with Options 001 and 002. On signal generators with Option 1EM, this output is changed from a BNC to an SMB

connector.

When using the real-time W-CDMA uplink personality, this connector is used to connect the external baseband generator data clock.

Digital Personality Revisions for ESG Models

Table 1-9

Format	E443xB Int. ARB	E443xB Real Time	E4438C Int. ARB	E4438C Real Time	E443xB/C Sig Studio	E443xB Opt #	E4438C Opt #
WCDMA UL DL	 3GPP Dec-00 Release 3GPP Dec-00 Release	 3GPP Dec-00 Release 3GPP Dec-00 Release	 3GPP June-01 Release 3GPP June-01 Release	 3GPP June-01 Release 3GPP June-01 Release	 Not offered Not offered	 ARB=100, UL & DL RT=200, UL & DL	400
GSM	Correct Mod/rate/ filter only	July 1996, V5.2.0	Correct Mod/rate/ filter only	ETSI TS 100 908 (3GPP TS 05.02) V8.9.0, 2001-04 (Release 1999)	Not offered	Part of UN8 base personalities (not a separate opt)	402
BS BERT Multi-frame	Not offered	GSM 05.03 V3.6.1, Oct 94	Not offered	GSM 05.03 V8.6.0 Rel. 1999		300	
EDGE	Correct Mod/rate/ filter only	GSM 05.03 V8.5.0 Release 1999	Correct Mod/rate/ filter only	ETSI TS 100 908 (3GPP TS 05.02) V8.9.0, 2001-04 (Release 1999)	Not offered	202	402
BS BERT Multi-frame	Not offered	GSM 05.03 V8.5.0 Release 1999	Not offered	GSM 05.03 V8.6.0 Release 1999		300	
cdma2000	3GPP2 C.5002-0-2 V1.13, Apr 24, 2001	3GPP2 C.5002-0-2 V1.13, Apr 24, 2001	3GPP2 C.5002-0-2 V1.13, Apr 24, 2001	3GPP2 C.5002-0-2 V1.13, Apr 24, 2001	Not offered	201	401
cdmaONE	IS-95A	Not offered	IS-95A	Not offered	Not offered	101	401
1x-EV	Not offered	Not offered	Not offered	Not offered	IS-856	404	404
Bluetooth	V1.1	Correct Mod/rate/ filter only	V1.1	Correct Mod/rate/ filter only	V1.1	406	406
802.11a	Not offered	Not offered	Not offered	Not offered	IEEE Std 802.11a-1999 (OFDM)	410	410
802.11b	Not offered	Not offered	Not offered	Not offered	IEEE Std 802.11b-1999 (DSSS)	405	405

2 Fundamental Operation

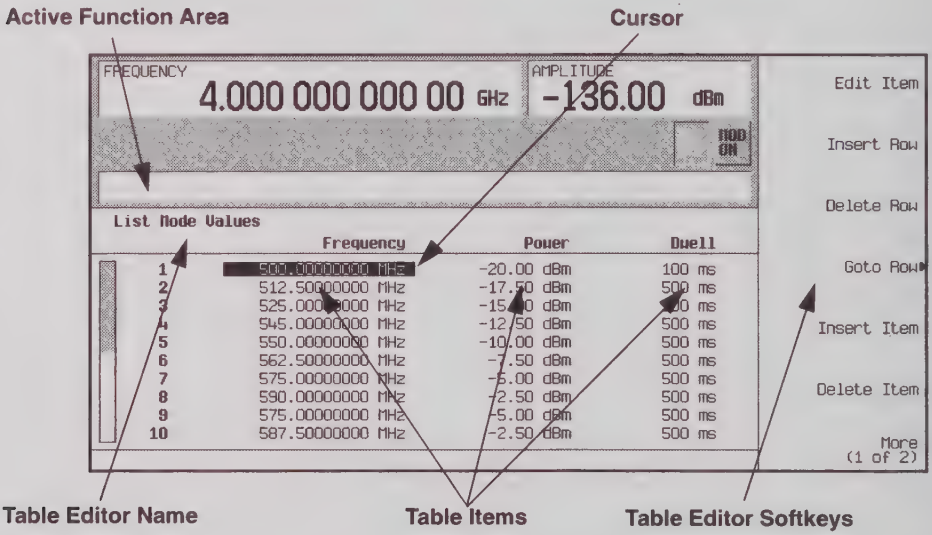
Using Table Editors

The signal generator table editors enable you to simplify configuration tasks, such as creating a list sweep. This section familiarizes you with basic table editor functionality using the List Mode Values table editor as an example.

Press **Preset** > **Sweep/List** > **Configure List Sweep**.

The signal generator displays the List Mode Values table editor, as shown below.

Figure 2-1



Active Function Area	displays the active table item while its value is edited
Cursor	an inverse video identifier used to highlight specific table items for selection and editing
Table Editor Softkeys	select table items, preset table values, and modify table structures
Table Items	values arranged in numbered rows and titled columns (The columns are also known as data fields. For example, the column below the Frequency title is known as the Frequency data field).

Table Editor Softkeys

The following table editor softkeys are used to load, navigate, modify, and store table item values. Press **More (1 of 2)** to access **Load/Store** and its associated softkeys.

Edit Item	displays the selected item in the active function area of the display where the item's value can be modified.
Insert Row	inserts an identical row of table items above the currently selected row.
Delete Row	deletes the currently selected row.
Goto Row	opens a menu of softkeys (**Enter**, **Goto Top Row**, **Goto Middle Row**, **Goto Bottom Row**, **Page Up**, and **Page Down**) used to quickly navigate through the table items.
Insert Item	inserts an identical item in a new row below the currently selected item.
Delete Item	deletes the item from the bottom row of the currently selected column.
Page Up and **Page Down**	displays table items that occupy rows outside the limits of the ten-row table display area.
Load/Store	opens a menu of softkeys (**Load From Selected File**, **Store To File**, **Delete File**, **Goto Row**, **Page Up**, and **Page Down**) used to load table items from a file in the memory catalog, or to store the current table items as a file in the memory catalog.

Modifying Table Items in the Data Fields

To modify existing table items:

1. Use the arrow keys or the knob to move the table cursor over the desired item. In Figure 2-1 on page 32, the first item in the Frequency data field has been selected.
2. Press **Edit Item**.

   The selected item is displayed in the active function area of the display.
3. Use the knob, arrow keys, or the numeric keypad to modify the value.
4. Press **Enter**.

   The modified item is now displayed in the table.

Configuring the RF Output

This section will show you how to create continuous wave and swept RF outputs.

Configuring a Continuous Wave RF Output

Using these procedures, you will learn how to set the following parameters:

- RF output frequency
- frequency reference and frequency offset
- RF output amplitude
- amplitude reference and amplitude offset

Setting the RF Output Frequency

1. Press **Preset**.

   This returns the signal generator to the factory-defined state.

NOTE You can change the preset condition of the signal generator to a user-defined state. For these examples, however, use the factory-defined preset state (the **Preset Normal User** softkey in the Utility menu must be set to Normal).

2. Observe the FREQUENCY area of the display (in the upper left-hand corner).

   The value displayed is the maximum specified frequency of the signal generator.

3. Press **RF On/Off**.

   The **RF On/Off** hardkey must be pressed before the RF signal is available at the RF OUTPUT connector. The display annunciator changes from RF OFF to RF ON. The maximum specified frequency is now being output at the RF OUTPUT connector (at the signal generator's minimum power level).

4. Press **Frequency** > **700** > **MHz**.

   The 700 MHz RF frequency is now displayed in the FREQUENCY area of the display and also in the active entry area.

5. Press **Frequency** > **Incr Set** > **1** > **MHz**.

   This changes the frequency increment value to 1 MHz.

6. Press the up arrow key.

   Each press of the up arrow key increases the frequency by the increment value last set with the **Incr Set** hardkey. The increment value is displayed in the active entry area.

7. The down arrow decreases the frequency by the increment value set in the previous step. Practice stepping the frequency up and down in 1 MHz increments.

   You can also adjust the RF output frequency using the knob. As long as frequency is the active function (the frequency is displayed in the active entry area), the knob will increase and decrease the RF output frequency.

8. Use the knob to adjust the frequency back to 700 MHz.

Setting the Frequency Reference and Frequency Offset

The following procedure sets the RF output frequency as a reference frequency to which all other frequency parameters are relative. The frequency initially shown on the display will be `0.00 Hz` (the frequency output by the hardware minus the reference frequency). Although the display changes, the frequency output does not change. Any subsequent frequency changes are shown as incremental or decremental to 0 Hz.

1. Press **Preset**.
2. Press **Frequency** > **700** > **MHz**.
3. Press **Freq Ref Set**.

   This activates the frequency reference mode and sets the current output frequency (700 MHz) as the reference value. The `FREQUENCY` area displays `0.00 Hz`, which is the frequency output by the hardware (700 MHz) minus the reference value (700 MHz). The `REF` indicator is activated and the **Freq Ref Off On** softkey has toggled to On.

4. Press **RF On/Off**.

   The display annunciator has changed from `RF OFF` to `RF ON`. The RF frequency at the RF OUTPUT connector is 700 MHz.

5. Press **Frequency** > **Incr Set** > **1** > **MHz**.

   This changes the frequency increment value to 1 MHz.

6. Press the up arrow key.

   This increments the output frequency by 1 MHz. The `FREQUENCY` area display changes to show `1.000 000 00 MHz`, which is the frequency output by the hardware (700 MHz + 1 MHz) minus the reference frequency (700 MHz). The frequency at the RF OUTPUT changes to 701 MHz.

7. Press **Freq Offset** > **1** > **MHz**.

   This enters a 1 MHz offset. The FREQUENCY area displays 2.000 000 00 MHz, which is the frequency output by the hardware (701 MHz) minus the reference frequency (700 MHz) plus the offset (1 MHz). The OFFS indicator is activated. The frequency at the RF OUTPUT connector is still 701 MHz.

Setting the RF Output Amplitude

1. Press **Preset**.
2. Observe the AMPLITUDE area of the display.

   The display reads the minimum power level of the signal generator. This is the normal preset RF output amplitude.

3. Press **RF On/Off**.

   The display annunciator changes from RF OFF to RF ON. The RF signal is now being output at the minimum power level at the RF OUTPUT connector.

4. Press **Amplitude** > **–20** > **dBm**.

   This changes the amplitude to –20 dBm. The new –20 dBm RF output power is now displayed in the AMPLITUDE area of the display and also in the active entry area.

   Amplitude is still the active function until you press another front panel function key. You can also change the amplitude using the up and down arrow keys and the knob.

Setting the Amplitude Reference and Amplitude Offset

The following procedure sets the RF output power as an amplitude reference to which all other amplitude parameters are relative. The amplitude initially shown on the display will be 0 dB (the power output by the hardware minus the reference power). Although the display changes, the output power does not change. Any subsequent power changes are shown as incremental or decremental to 0 dB.

1. Press **Preset**.
2. Press **Amplitude** > **–20** > **dBm**.
3. Press **More (1 of 2)** > **Ampl Ref Set**.

   This activates the amplitude reference mode and sets the current output power (–20 dBm) as the reference value. The AMPLITUDE area displays 0.00 dB, which is the power output by the hardware (20 dBm) minus the reference value (–20 dBm). The REF indicator is activated and the **Ampl Ref Off On** softkey has toggled to On.

4. Press **RF On/Off**.

   The display annunciator has changed from `RF OFF` to `RF ON`. The power at the RF OUTPUT connector is –20 dBm.

5. Press **Incr Set > 10 > dB**.

   This changes the amplitude increment value to 10 dB.

6. Use the up arrow key to increase the output power by 10 dB.

   The `AMPLITUDE` area displays `10.00 dB`, which is the power output by the hardware (–20 dBm plus 10 dBm) minus the reference power (–20 dBm). The power at the RF OUTPUT connector changes to –10 dBm.

7. Press **Ampl Offset > 10 > dB**.

   This enters a 10 dB offset. The `AMPLITUDE` area displays `20.00 dB`, which is the power output by the hardware (–10 dBm) minus the reference power (–20 dBm) plus the offset (10 dB). The `OFFS` indicator is activated. The power at the RF OUTPUT connector is still –10 dBm.

Configuring a Swept RF Output

The signal generator has two sweep types: step and list.

NOTE List sweep data cannot be saved within an instrument state, but *can* be saved to the memory catalog. For instructions on saving list sweep data, see "Storing Files" on page 50.

During swept RF output, the `FREQUENCY` and `AMPLITUDE` areas of the signal generator's display are deactivated, depending on what is being swept.

This section provides an explanation of the differences between step sweep and list sweep. You will learn two ways to configure the signal generator's RF output to sweep a defined set of frequency and amplitude points. You will create a step sweep and then you will use these points as the basis for a new list sweep.

Step Sweep

When a step sweep is activated, the signal generator sweeps the RF output based on the values entered for RF output start and stop frequencies and amplitudes, a number of equally spaced points (steps) to dwell upon, and the amount of dwell time at each point. The frequency, amplitude, or frequency *and* amplitude of the RF output will sweep from the start amplitude/frequency to the stop amplitude/frequency, dwelling at equally spaced intervals defined by the **# Points** softkey value.

Step sweep provides a linear progression through the start-to-stop frequency and/or amplitude values. You can toggle the direction of the sweep, up or down. When the **Sweep Direction Down Up** softkey is set to Up, values are swept from the start frequency/amplitude to the stop frequency/amplitude. When set to Down, values are swept from the stop frequency/amplitude to the start frequency/amplitude.

Configuring and Activating a Single Step Sweep

In this procedure, you will create a step sweep with nine, equally spaced points and the following parameters:

- frequency range from 500 MHz to 600 MHz
- amplitude from –20 dBm to 0 dBm
- dwell time 500 ms at each point

1. Press **Preset**.
2. Press **Sweep/List**.

   This opens a menu of sweep softkeys.
3. Press **Sweep Repeat Single Cont**.

   This toggles the sweep repeat from continuous to single.
4. Press **Configure Step Sweep.**
5. Press **Freq Start > 500 > MHz**.

   This changes the start frequency of the step sweep to 500 MHz.
6. Press **Freq Stop > 600 > MHz**.

   This changes the stop frequency of the step sweep to 600 MHz.
7. Press **Ampl Start > –20 > dBm**.

   This changes the amplitude level for the start of the step sweep.
8. Press **Ampl Stop > 0 > dBm**.

   This changes the amplitude level for the end of the step sweep.
9. Press **# Points > 9 > Enter**.

   This sets the number of sweep points to nine.
10. Press **Step Dwell > 500 > msec**.

    This sets the dwell time at each point to 500 milliseconds.

11. Press **Return** > **Sweep** > **Freq & Ampl**.

    This sets the step sweep to sweep both frequency and amplitude data. Selecting this softkey returns you to the previous menu and turns on the sweep function.

12. Press **RF On/Off**.

    The display annunciator changes from `RF OFF` to `RF ON`.

13. Press **Single Sweep**.

    A single sweep of the frequencies and amplitudes configured in the step sweep is executed and available at the RF OUTPUT connector. On the display, the `SWEEP` annunciator appears for the duration of the sweep, and a progress bar shows the progression of the sweep. The **Single Sweep** softkey can also be used to abort a sweep in progress.

Activating Continuous Step Sweep

Press **Sweep Repeat Single Cont**.

This toggles the sweep from single to continuous. A continuous repetition of the frequencies and amplitudes configured in the step sweep are now available at the RF OUTPUT connector. The `SWEEP` annunciator appears on the display, indicating that the signal generator is sweeping, and progression of the sweep is shown by a progress bar.

List Sweep

List sweep allows you to create a list of arbitrary frequency, amplitude, and dwell time values and sweep the RF output based on the entries in the List Mode Values table.

Unlike a step sweep that contains linear ascending/descending frequency and amplitude values spaced at equal intervals throughout the sweep, list sweep frequencies and amplitudes can be entered at unequal intervals, nonlinear ascending/descending, or random order.

For convenience, the List Mode Values table can be copied from a previously configured step sweep. Each step sweep point's associated frequency, amplitude and dwell time values are entered into a row in the List Mode Values table, as the following example illustrates.

Configuring a List Sweep Using Step Sweep Data

In this procedure, you will leverage the step sweep points and change the sweep information by editing several points in the List Mode Values table editor. For information on using table editors, see "Using Table Editors" on page 32.

1. Press **Sweep Repeat Single Cont**.

   This toggles the sweep repeat from continuous to single. The `SWEEP` annunciator is turned off. The sweep will not occur until it is triggered.

2. Press **Sweep Type List Step**.

   This toggles the sweep type from step to list.

3. Press **Configure List Sweep**.

   This opens another menu displaying softkeys that you will use to create the sweep points. The display shows the current list data. (When no list has been previously created, the default list contains one point set to the signal generator's maximum frequency, minimum amplitude, and a dwell time of 2 ms.)

4. Press **More (1 of 2)** > **Load List From Step Sweep** > **Confirm Load From Step Sweep**.

   The points you defined in the step sweep are automatically loaded into the list.

Editing List Sweep Points

1. Press **Return** > **Sweep** > **Off**.

   Turning the sweep off allows you to edit the list sweep points without generating errors. If sweep remains on during editing, errors occur whenever one or two point parameters (frequency, power, and dwell) are undefined.

2. Press **Configure List Sweep**.

   This returns you to the sweep list table.

3. Use the arrow keys to highlight the dwell time in row 1.

4. Press **Edit Item**.

   The dwell time for point 1 becomes the active function.

5. Press **100** > **msec**.

   This enters 100 ms as the new dwell time value for row 1. Note that the next item in the table (in this case, the frequency value for point 2) becomes highlighted after you press the terminator softkey.

6. Using the arrow keys, highlight the frequency value in row 4.

7. Press **Edit Item** > **545** > **MHz**.

   This changes the frequency value in row 4 to 545 MHz.

8. Highlight any column in the point 7 row and press **Insert Row**.

   This adds a new point between points 7 and 8. A copy of the point 7 row is placed between points 7 and 8, creating a new point 8, and renumbering the successive points.

9. Highlight the frequency item for point 8, then press **Insert Item**.

   Pressing **Insert Item** shifts frequency values down one row, beginning at point 8. Note that the original frequency values for both points 8 and 9 shift down one row, creating an entry for point 10 that contains only a frequency value (the power and dwell time items do not shift down).

   The frequency for point 8 is still active.

10. Press **590** > **MHz**.

11. Press **Insert Item** > **–2.5** > **dBm**.

    This inserts a new power value at point 8 and shifts down the original power values for points 8 and 9 by one row.

12. Highlight the dwell time for point 9, then press **Insert Item**.

    A duplicate of the highlighted dwell time is inserted for point 9, shifting the existing value down to complete the entry for point 10.

Activating List Sweep for a Single Sweep

1. Press **Return** > **Sweep** > **Freq & Ampl**

   This turns the sweep on again. No errors should occur if all parameters for every point have been defined in the previous editing process.

2. Press **Single Sweep**.

   The signal generator will single sweep the points in your list. The SWEEP annunciator activates during the sweep.

3. Press **More (1 of 2)** > **Sweep Trigger** > **Trigger Key**.

   This sets the sweep trigger to occur when you press the **Trigger** hardkey.

4. Press **More (2 of 2)** > **Single Sweep**.

   This arms the sweep. The ARMED annunciator is activated.

5. Press the **Trigger** hardkey.

   The signal generator will single sweep the points in your list and the SWEEP annunciator will be activated during the sweep.

Creating and Applying User Flatness Correction

User flatness correction allows the digital adjustment of RF output amplitude for up to 1601 frequency points in any frequency or sweep mode. Using an Agilent E4416A/17A or E4418B/19B power meter (controlled by the signal generator through GPIB) to calibrate the measurement system, a table of power level corrections is created for frequencies where power level variations or losses occur. These frequencies may be defined in sequential linear steps or arbitrarily spaced.

If you do not have an Agilent E4416A/17A or E4418B/19B power meter, or if your power meter does not have a GPIB interface, the correction values can be manually entered into the signal generator.

To allow different correction arrays for different test setups or different frequency ranges, you may save individual user flatness correction tables to the signal generator's memory catalog and recall them on demand.

Follow the steps in the next sections to create and apply user flatness correction to the signal generator's RF output.

Afterward, follow the steps in "Recalling and Applying a User Flatness Correction Array" on page 47 to recall a user flatness file from the memory catalog and apply it to the signal generator's RF output.

Creating a User Flatness Correction Array

In this example, you will create a user flatness correction array. The flatness correction array contains ten frequency correction pairs (amplitude correction values for specified frequencies), from 1 to 4 GHz in 1 GHz intervals.

An Agilent E4416A/17A/18B/19B power meter (controlled by the signal generator via GPIB) and E4413A power sensor are used to measure the RF output amplitude at the specified correction frequencies and transfer the results to the signal generator. The signal generator reads the power level data from the power meter, calculates the correction values, and stores the correction pairs in the user flatness correction array.

If you do not have the required Agilent power meter, or if your power meter does not have a GPIB interface, you can enter correction values manually.

Required Equipment

- Agilent E4416A/17A/18B/19B power meter
- Agilent E4413A E Series CW power sensor

- GPIB interface cable
- adapters and cables, as required

Configure the Power Meter

1. Select SCPI as the remote language for the power meter.
2. Zero and calibrate the power sensor to the power meter.
3. Enter the appropriate power sensor calibration factors into the power meter as appropriate.
4. Enable the power meter's cal factor array.

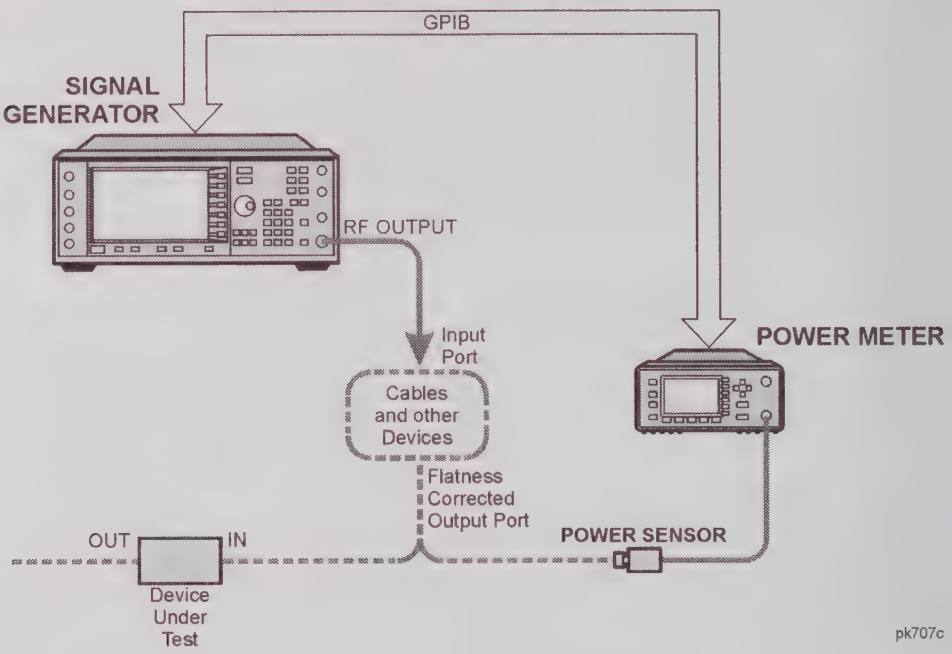
NOTE For operating information on your particular power meter/sensor, refer to its operating guide.

Connect the Equipment

Connect the equipment as shown in Figure 2-2 on page 44.

NOTE During the process of creating the user flatness correction array, the power meter is controlled by the signal generator via GPIB. No other controllers are allowed on the GPIB interface.

Figure 2-2 User Flatness Correction Equipment Setup



Configure the Signal Generator

1. Press **Preset**.
2. Configure the signal generator to interface with the power meter.
   a. Press **Amplitude** > **More (1 of 2)** > **User Flatness** > **More (1 of 2)** > **Power Meter** > **E4416A**, **E4417A**, **E4418B**, or **E4419B**.
   b. Press **Meter Address** > enter the power meter's GPIB address > **Enter**.
   c. For E4417A and E4419B power meters, press **Meter Channel A B** to select the power meter's active channel.
   d. Press **Meter Timeout** to adjust the length of time before the instrument generates a timeout error if unsuccessfully attempting to communicate with the power meter.
3. Press **More (2 of 2)** > **Configure Cal Array** > **More (1 of 2)** > **Preset List** > **Confirm Preset**.

   This opens the User Flatness table editor and presets the cal array frequency/correction list.

4. Press **Configure Step Array**.

   This opens a menu for entering the user flatness step array data.

5. Press **Freq Start** > **500** > **MHz**.

6. Press **Freq Stop** > **1** > **GHz**.

7. Press **# of Points** > **10** > **Enter**.

   Steps 4, 5, and 6 enter the desired flatness-corrected frequencies into the step array.

8. Press **Return** > **Load Cal Array From Step Array** > **Confirm Load From Step Sweep**.

   This populates the user flatness correction array with the frequency settings defined in the step array.

9. Press **Amplitude** > **0** > **dBm**.

10. Press **RF On/Off**.

    This activates the RF output and the `RF ON` annunciator is displayed on the signal generator.

Perform the User Flatness Correction

NOTE If you are not using an Agilent E4416A/17A/18B/19B power meter, or if your power meter does not have a GPIB interface, you can perform the user flatness correction manually. For instructions, see "Performing the User Flatness Correction Manually" on page 46.

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1. Press **More (1 of 2)** > **User Flatness** > **Do Cal**.

   This creates the user flatness amplitude correction value table entries. The signal generator enters the user flatness correction routine and a progress bar is shown on the display.

2. When prompted, press **Done**.

   This loads the amplitude correction values into the user flatness correction array.

   If desired, press **Configure Cal Array**.

   This opens the user flatness correction array, where you can view the stored amplitude correction values. The user flatness correction array title displays `User Flatness: (UNSTORED)` indicating that the current user flatness correction array data has not been saved to the memory catalog.

Performing the User Flatness Correction Manually

If you are not using an Agilent E4416A/17A/18B/19B power meter, or if your power meter does not have a GPIB interface, complete the steps in this section and then continue with the user flatness correction tutorial.

1. Press **More (1 of 2)** > **User Flatness** > **Configure Cal Array**.

   This opens the User Flatness table editor and places the cursor over the frequency value (1 GHz) for row 1. The RF output changes to the frequency value of the table row containing the cursor and `1.000 000 000 00` is displayed in the `AMPLITUDE` area of the display.

2. Observe and record the measured value from the power meter.
3. Subtract the measured value from 0 dBm.
4. Move the table cursor over the correction value in row 1.
5. Press **Edit Item** > enter the difference value from step 3 > **dB**.

   The signal generator adjusts the RF output amplitude based on the correction value entered.

6. Repeat steps 2 through 5 until the power meter reads 0 dBm.
7. Use the down arrow key to place the cursor over the frequency value for the next row. The RF output changes to the frequency value of the table row containing the cursor, as shown in the `AMPLITUDE` area of the display.
8. Repeat steps 2 through 7 for every entry in the User Flatness table.

Save the User Flatness Correction Data to the Memory Catalog

This process allows you to save the user flatness correction data in the signal generator's memory catalog. With several user flatness correction files saved to the memory catalog, any file can be recalled, loaded into the correction array, and applied to the RF output to satisfy specific RF output flatness requirements.

1. Press **Load/Store**.
2. Press **Store to File**.
3. Enter the file name `FLATCAL1` using the alphanumeric softkeys, numeric keypad, or the knob.
4. Press **Enter**.

The user flatness correction array file FLATCAL1 is now stored in the memory catalog as a `UFLT` file.

Applying a User Flatness Correction Array

Press **Return** > **Return** > **Flatness Off On**.

This applies the user flatness correction array to the RF output. The UF indicator is activated in the AMPLITUDE section of the signal generator's display and the frequency correction data contained in the correction array is applied to the RF output amplitude.

Recalling and Applying a User Flatness Correction Array

Before performing the steps in this section, complete "Creating a User Flatness Correction Array" on page 42.

1. Press **Preset**.
2. Press **Amplitude** > **More (1 of 2)** > **User Flatness** > **Configure Cal Array** > **More (1 of 2)** > **Preset List** > **Confirm Preset**.
3. Press **More (2 of 2)** > **Load/Store**.
4. Ensure that the file FLATCAL1 is highlighted.
5. Press **Load From Selected File** > **Confirm Load From File**.

   This populates the user flatness correction array with the data contained in the file FLATCAL1. The user flatness correction array title displays User Flatness: FLATCAL1.
6. Press **Return** > **Flatness Off On**.

   This applies the user flatness correction data contained in FLATCAL1.

Returning the Signal Generator to GPIB Listener Mode

During the user flatness correction process, the power meter is controlled by the signal generator via GPIB, and no other controllers are allowed on the GPIB interface. The signal generator operates in GPIB talker mode, as a device controller for the power meter. In this operating mode, it cannot receive SCPI commands via GPIB.

NOTE Before interfacing the signal generator to a remote controller, the signal generator must be in GPIB listener mode. Press **Preset** to return the signal generator from GPIB talker mode to GPIB listener mode.

If an RF carrier has been previously configured, you must save the present instrument state before returning the signal generator to GPIB listener mode.

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1. Save your instrument state to the instrument state register.

   For instructions, see "Saving an Instrument State" on page 50.

2. Press **GPIB Listener Mode**.

   This presets the signal generator and returns it to GPIB listener mode. The signal generator can now receive remote commands executed by a remote controller connected to the GPIB interface.

3. Recall your instrument state from the instrument state register.

   For instructions, see "Recalling an Instrument State" on page 51.

Using Data Storage Functions

This section explains how to use the two forms of signal generator data storage, the memory catalog and the instrument state register.

Using the Memory Catalog

The signal generator's interface for stored files is the memory catalog. From the memory catalog, you can view, store, and save files using the signal generator's front panel or a remote controller. (For information on performing these tasks remotely, see the *Programming Guide*.)

The memory catalog may contain the following file types and their associated data:

`BIN`	binary data
`LIST`	sweep data from the List Mode Values table including frequency, amplitude, and dwell time
`STAT`	instrument state data (controlling instrument operating parameters, such as frequency, amplitude, and mode)
`UFLT`	user flatness calibration correction pair data (user-defined frequency and corresponding amplitude correction values)

NOTE You may have additional file types depending on which options you have installed in your signal generator.

Viewing Stored Files

1. Press **Utility** > **Memory Catalog** > **Catalog Type**.

   All files in the memory catalog are listed in alphabetical order, regardless of which catalog type you select. File information appears on the display and includes the file name, file type, file size, and the file modification date and time.

2. Press **List**

   The Catalog of List Files is displayed.

3. Press **Catalog Type** > **State**.

   The Catalog of State Files is displayed.

4. Press **Catalog Type** > **User Flatness**.

   The Catalog of USERFLAT Files is displayed.

Storing Files

To store a file to the memory catalog, first create a file. For this example, use the default list sweep table.

1. Press **Preset**.
2. Press **Sweep/List** > **Configure L1ist Sweep** > **More (1 of 2)** > **Load/Store**.

   This opens the Catalog of List Files.
3. Press **Store to File**.

   This displays a menu of alphabetical softkeys for naming the file. `Store to:` is displayed in the active function area.
4. Enter the file name `LIST1` using the alphabetical softkeys and the numeric keypad.
5. Press **Enter**.

   The file is now displayed in the Catalog of List Files, showing the file name, file type, file size, and the date and time the file was modified.

Using the Instrument State Register

The instrument state register is a section of memory divided into 10 sequences (numbered 0 through 9) each containing 100 registers (numbered 00 through 99). It is used to store and recall instrument settings. It provides a quick way to reconfigure the signal generator when switching between different signal configurations. Once an instrument state has been saved, you can recall the instrument settings for that state with minimum effort.

NOTE List sweep data is not saved within an instrument state. For instructions on saving list sweep data, see "Storing Files" on page 50.

Saving an Instrument State

Using this procedure, you will learn how to save current signal generator settings to the instrument state register.

1. Press **Preset**.

2. Configure the signal generator with the following settings:

   a. Press **Frequency** > **800** > **MHz**.

   b. Press **Amplitude** > **0** > **dBm**.

   c. Press **AM** > **AM Off On**.

      This enables amplitude modulation (the AM annunciator is on).

3. Press **Save** > **Select Seq**.

   The sequence number becomes the active function. The signal generator displays the last sequence that you have used. Set the sequence to 1 using the arrow keys.

4. Press **Select Reg**.

   The register number in sequence 1 becomes the active function. The signal generator displays either the last register used, accompanied by the text: `(in use)`, or (if no registers are in use) register 00, accompanied by the text: `(available)`. Use the arrow keys to select register 01.

5. Press **Save Seq[1] Reg[01]**.

   This will save this instrument state in sequence 1, register 01 of the instrument state register.

6. Press **Add Comment to Seq[1] Reg[01]**.

   This allows you to add a descriptive comment to sequence 1 register 01.

7. Enter your comment using the alphanumeric softkeys or the knob and press **Enter**.

8. Press **Edit Comment In Seq[1] Reg[01]**.

   This allows you to change the descriptive comment for sequence 1 register 01, if desired. Change your comment using the alphanumeric softkeys and press **Enter**.

After making changes to an instrument state, you may save it back to a specific register by highlighting that register and pressing **Re-SAVE Seq[n] Reg[nn]**.

Recalling an Instrument State

Using this procedure, you will learn how to recall instrument settings saved to an instrument state register.

1. Press **Preset**.

2. Press the **Recall** hardkey.

   Notice that the **Select Seq** softkey shows sequence 1. (This is the last sequence that you

used.)

3. Press **RECALL Reg**.

   The register to be recalled in sequence 1 becomes the active function. Press the up arrow key once to select register 1. Your stored instrument state settings have now been recalled.

Deleting Registers and Sequences

Using this procedure, you will learn how to delete registers and sequences saved to an instrument state register.

To Delete a Specific Register within a Sequence

1. Press **Preset**.
2. Press the **Recall** or **Save** hardkey.

   Notice that the **Select Seq** softkey shows the last sequence that you used.

3. Press **Select Seq** and enter the sequence number containing the register you want to delete.
4. Press **Select Reg** and enter the register number you want to delete.

   Notice that the **Delete Seq[n] Reg[nn]** is now loaded with the sequence and register you want to delete.

5. Press **Delete Seq[n] Reg[nn]**.

   This deletes the chosen register.

To Delete All Registers within a Sequence

1. Press **Preset**.
2. Press the **Recall** or **Save** hardkey.

   Notice that the **Select Seq** softkey shows the last sequence that you used.

3. Press **Select Seq** and enter the sequence number containing the registers you want to delete.
4. Press **Delete all Regs in Seq[n]**.

   This deletes all registers in the selected sequence.

To Delete All Sequences

CAUTION This will delete the contents of all registers and all sequences contained in the instrument state register.

1. Press **Preset**.
2. Press the **Recall** or **Save** hardkey.

   Notice that the **Select Seq** softkey shows the last sequence that you used.
3. Press **Delete All Sequences**.

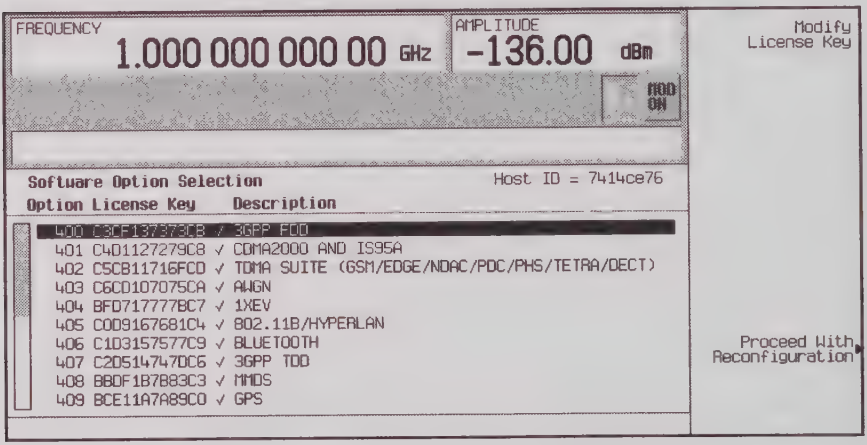
   This deletes all of the sequences saved in the instrument state register.

Enabling Options

You can retrofit your signal generator after purchase to add new capabilities. Some new optional features are implemented in hardware that you must install. Some options are implemented in software but require the presence of optional hardware in the instrument. This example shows you how to enable both hardware and software options.

Enabling a Software Option

1. A license key is required to enable each software option. This license key is provided on the license key certificate that you receive when you purchase the software option. Access the Software Options menu by pressing **Utility** > **Instrument Adjustments** > **Instrument Options** > **Software Options**. An example of the signal generator display follows:



   Verify that the host ID shown on the display matches the host ID on the license key certificate. The host ID is a unique number for every instrument. If the host ID on the license key certificate does not match your instrument, the license key cannot enable the software option.

2. On the display is a list of software options that are already enabled (if any) and the software options that can be enabled. Software options are linked to specific hardware options. Before a software option can be enabled, the appropriate hardware option must be installed. For example, Option 400, W-CDMA, requires that Option 001 or 002, Internal Baseband Generator, be installed. If the software option that you intend to install is listed in a grey font, the required hardware may not be installed. (Look for an X in the "Selected"

column of the appropriate hardware option in the Hardware Options menu.)

3. To enable the software option, highlight the desired option using the up/down arrow keys or the front panel knob.
4. Press **Modify License Key**. Enter the 12-character license key (from your license key certificate) using the softkeys and numeric keypad. When you have finished, press the **Enter** terminator softkey.
5. Press **Proceed With Reconfiguration** > **Confirm Change** to verify that you do want to reconfigure the signal generator with the options for which you have provided a license key. The instrument will enable the options and reboot.

Configuring for Remote Control

This section will show you how to configure the signal generator to interface with a remote controller. For more information refer to the programming guide.

NOTE Front panel keys are locked when using a remote controller. Only the **Local** key is active. To unlock the front panel keypad, press the **Local** key.

GPIB Interface Configuration

1. Press **Utility** > **GPIB/RS-232 LAN** > **GPIB Address**.
2. Use the numeric keypad to set the desired address.

   Alternatively, the arrow keys or the front panel knob can be used to set the desired address. If either alternative is used, step 3 is not required.
3. Press **Enter**.

The signal generator's GPIB address is set to 19 at the factory. The acceptable range of addresses is 0 through 30.

The GPIB address is a persistent state; it is not affected by a signal generator preset or by a power cycle.

LAN (10BASE-T) Interface Configuration

1. Obtain a hostname and IP address from your system administrator or IT department.
2. Press **Utility** > **GPIB/RS-232 LAN** > **LAN Setup**.
3. Press **Hostname**.
4. Use the labeled text softkeys and/or numeric keypad to enter the desired hostname. To erase the current hostname, press **Editing Keys** > **Clear Text**.
5. Press **Enter**.

6. Press **IP Address** and enter a desired address.

   Use the left and right arrow keys to move the cursor. Use the up and down arrow keys, front panel knob, or numeric keypad to enter an IP address. To erase the current IP address, press the **Clear Text** softkey.

NOTE To remotely access the signal generator from a different LAN subnet, you must also enter the subnet mask and default gateway. See your system administrator to obtain the appropriate values.

7. Press **Enter** > **Proceed With Reconfiguration** > **Confirm Change (Instrument will Reboot)**.

   The signal generator will reboot with the revised settings saved.

This assigns a hostname and IP address (as well as a gateway and subnet mask, if these have been configured) to the signal generator. The hostname, IP address, gateway and subnet mask are not affected by an instrument preset or by a power cycle

RS-232 Interface Configuration

1. Press **Utility** > **GPIB/RS-232 LAN** > **RS-232 Setup**.
2. Press **RS-232 Baud Rate**.
3. Press the desired baud rate softkey.
4. Press **RS-232 Echo Off On**.

   This toggles the state of the SCPI echoing on the RS-232 connection. Set as desired.

5. Press **Reset RS-232**.

   This deletes the data from the RS-232 buffer, discarding any unprocessed SCPI input received over RS-232.

These RS-232 parameters are not affected by an instrument preset or power cycle.

3 Analog Modulation

Configuring Analog Modulation

The signal generator can modulate the RF carrier with four types of analog modulation: amplitude, frequency, phase, and pulse.

Available internal waveforms include:

Sine	sine wave with adjustable amplitude and frequency
Dual-Sine	dual-sine waves with individually adjustable frequencies and a percent-of-peak-amplitude setting for the second tone (available from function generator only)
Swept-Sine	swept-sine wave with adjustable start and stop frequencies, sweep time, and sweep trigger settings (available from function generator only)
Triangle	triangle wave with adjustable amplitude and frequency
Ramp	ramp with adjustable amplitude and frequency
Square	square wave with adjustable amplitude and frequency

Configuring AM

Using this procedure, you will learn how to generate an amplitude-modulated RF carrier with the following characteristics:

- carrier frequency set to 1340 kHz
- power level set to 0 dBm
- AM depth set to 90%
- AM rate set to 10 kHz

Setting the Carrier Frequency

1. Press **Preset**.
2. Press **Frequency** > **1340** > **kHz**.

The FREQUENCY area of the display now reads `1.340 000 00 kHz`.

Setting the RF Output Amplitude

Press **Amplitude** > **0** > **dBm**.

The AMPLITUDE area of the display now reads `0.00 dBm`.

Setting the AM Depth and Rate

1. Press the **AM** hardkey.

   The first level menu of softkeys is displayed.
2. Press **AM Depth** > **90** > **%**.

   `90.0 %` is displayed below the **AM Depth** softkey.
3. Press **AM Rate** > **10** > **kHz**.

   `10.0000 kHz` is displayed below the **AM Rate** softkey.

Turning on Amplitude Modulation

The signal generator is now configured to output a 0 dBm, amplitude-modulated carrier at 1340 kHz with the AM depth set to 90% and the AM rate set to 10 kHz. The shape of the waveform is a sine wave (notice that sine is the default for the AM Waveform softkey). Follow these remaining steps to output the amplitude-modulated signal.

1. Press the **AM Off On** softkey.

   AM toggles from **Off** to **On**. Notice that the AM display annunciator is turned on indicating that you have enabled amplitude modulation.

2. Press the front panel **RF On Off** key.

   The RF ON annunciator is activated, indicating that the signal is now available at the RF OUTPUT connector.

Configuring FM

Using this procedure, you will learn how to create a frequency-modulated RF carrier with the following characteristics:

- RF output frequency set to 1 GHz
- RF output amplitude set to 0 dBm
- FM deviation set to 75 kHz
- FM rate set to 10 kHz

Setting the RF Output Frequency

1. Press **Preset**.
2. Press **Frequency** > **1** > **GHz**.

   The FREQUENCY area of the display now reads `1.000 000 000 00 GHz`.

Setting the RF Output Amplitude

Press **Amplitude** > **0** > **dBm**.

The AMPLITUDE area of the display now reads `0.00 dBm`.

Setting the FM Deviation and Rate

1. Press **FM/ΦM**.

   The first level menu of FM softkeys is displayed.

2. Press **FM Dev > 75 > kHz**.

   `75.000 0 kHz` is displayed below the **FM Dev** softkey.

3. Press **FM Rate > 10 > kHz**.

   `10.000 0 kHz` is displayed below the **FM Rate** softkey.

The signal generator is now configured to output a 0 dBm, frequency-modulated carrier at 1 GHz with a 75 kHz deviation and a 10 kHz rate. The shape of the waveform is a sine wave. (Notice that sine is the default for the **FM Waveform** softkey. Press **More (1 of 2)** to see the softkey.)

Activating FM

Follow these remaining steps to output the frequency-modulated signal.

1. Press **FM Off On**.

   The `FM` annunciator is activated indicating that you have enabled frequency modulation.

2. Press **RF On/Off**.

   The `RF ON` annunciator is activated, indicating that the signal is now available at the RF OUTPUT connector.

Configuring ΦM

Using this procedure, you will learn how to create a phase-modulated RF carrier with the following characteristics:

- RF output frequency set to 3.0 GHz
- RF output amplitude set to 0 dBm
- ΦM deviation set to 0.25 π radians
- ΦM rate set to 30 kHz

Setting the RF Output Frequency

1. Press **Preset**.
2. Press **Frequency** > **3** > **GHz**.

   The FREQUENCY area of the display now reads `3.000 000 000 00 GHz`.

Setting the RF Output Amplitude

Press **Amplitude** > **0** > **dBm**.

The AMPLITUDE area of the display now reads `0.00 dBm`.

Setting the ΦM Deviation and Rate

1. Press the **FM/ΦM** hardkey.
2. Press the **FM ΦM** softkey.

   The first level menu of ΦM softkeys is displayed.
3. Press **ΦM Dev** > **.25** > **pi rad**.

   This changes the ΦM deviation to 0.25 π radians.
4. Press **ΦM Rate** > **10** > **kHz**.

   This sets the ΦM rate to 10 kHz.

The signal generator is now configured to output a 0 dBm, phase-modulated carrier at 3 GHz with a 0.25 π radian deviation and 10 kHz rate. The shape of the waveform is a sine wave. (Notice that sine is the default for the **ΦM Waveform** softkey. Press **More (1 of 2)** to see the softkey.)

Activating ΦM

Follow these remaining steps to output the phase-modulated signal.

1. Press **ΦM Off On**.

   The ΦM annunciator is activated, indicating that you have enabled phase modulation.

2. Press **RF On/Off**.

   The RF ON annunciator is activated, indicating that the signal is now available at the RF OUTPUT connector.

Configuring Pulse Modulation

Using the following procedure you will learn how to create a pulse-modulated RF carrier with the following characteristics:

- RF output frequency set to 2 GHz
- RF output amplitude set to 0 dBm
- pulse period set to 100.0 µs
- pulse width set to 24.0 µs
- pulse source set to internal free-run

Setting the RF Output Frequency

1. Press **Preset**.
2. Press **Frequency** > **2** > **GHz**.

   The FREQUENCY area of the display now reads `2.000 000 000 00 GHz`.

Setting the RF Output Amplitude

Press **Amplitude** > **0** > **dBm**.

The AMPLITUDE area of the display now reads `0.00 dBm`.

Setting the Pulse Period and Width

1. Press **Pulse** > **Pulse Period** > **100** > **usec**.

   This sets the pulse period to 100 microseconds.

2. Press **Pulse** > **Pulse Width** > **24** > **usec**.

   This sets the pulse period to 24 microseconds.

The signal generator is now configured to output a 0 dBm, pulse-modulated carrier at 2 GHz with a 100-microsecond pulse period and 24-microsecond pulse width. The pulse source is set to internal free-run. (Notice that internal free-run is the default for the **Pulse Source** softkey.)

Activating Pulse Modulation

Follow these remaining steps to output the pulse-modulated signal.

1. Press **Pulse Off On**.

   This activates pulse modulation. The `Pulse` annunciator is activated indicating that you have enabled pulse modulation.

2. Press **RF On/Off**.

   The `RF ON` annunciator is activated, and the signal is now available at the RF OUTPUT.

Configuring the LF Output

The signal generator has a low frequency (LF) output. The LF output's source can be switched between an internal modulation source or an internal function generator.

Using internal modulation (**Internal Monitor**) as the LF output source, the LF output provides a replica of the signal from the internal source that is being used to modulate the RF output. The specific modulation parameters for this signal are configured through the AM, FM, or ΦM menus.

Using function generator as the LF output source, the function generator section of the internal modulation source drives the LF output directly. Frequency and waveform are configured from the LF output menu, not through the AM, FM, or ΦM menus. You can select the waveform shape from the following choices:

Sine	sine wave with adjustable amplitude and frequency
Dual-Sine	dual-sine waves with individually adjustable frequencies and a percent-of-peak-amplitude setting for the second tone (available from function generator only)
Swept-Sine	a swept-sine wave with adjustable start and stop frequencies, sweep time, and sweep trigger settings (available from function generator only)
Triangle	triangle wave with adjustable amplitude and frequency
Ramp	ramp with adjustable amplitude and frequency
Square	square wave with adjustable amplitude and frequency
Noise	noise, in a uniform or Gaussian distribution, with adjustable amplitude generated as a peak-to-peak value (RMS value is approximately 80% of the displayed value)
DC	direct current with adjustable amplitude

NOTE The **LF Out Off On** softkey controls the operating state of the LF output when the LF output source is set to **Function Generator**. The **Mod On/Off** softkey controls the operating state of the LF OUTPUT connector when the LF output source is set to **Internal Monitor**.

The **RF On/Off** softkey does not apply to the LF OUTPUT connector.

Configuring the LF Output with an Internal Modulation Source

In this example, the internal FM modulation is the LF output source.

NOTE Internal modulation (**Internal Monitor**) is the default LF output source.

Configuring the Internal Modulation as the LF Output Source

1. Press **Preset**.
2. Press the **FM/ΦM** hardkey.
3. Press **FM Dev > 75 > kHz**.

   This sets the FM deviation to 75 kHz.
4. Press **FM Rate > 10 > kHz**.

   This sets the FM rate to 10 kHz.
5. Press **FM Off On**.

   The FM annunciator is activated indicating that you have enabled frequency modulation.

Configuring the Low Frequency Output

1. Press the **LF Out** hardkey.

   This opens the Low Frequency Output menu. The LF output source is set to internal modulation by default.
2. Press **LF Out Amplitude > 3 > Vp**.

   This sets the LF output amplitude to 3 Vp. `3.000 Vp` is displayed below the **LF Out Amplitude** softkey.
3. Press **LF Out Off On**.

   The LF output is a 3 Vp frequency modulated sine wave (the default signal shape), with a 75 kHz FM deviation and 10 kHz rate.

Configuring the LF Output with a Function Generator Source

In this example, function generator is the LF output source.

Configuring the Function Generator as the LF Output Source

1. Press **Preset**.
2. Press the **LF Out** hardkey.
3. Press **LF Out Source** > **Function Generator**.

   Function generator becomes the LF output source and FuncGen is displayed below the **LF Out Source** softkey.

Configuring the Waveform

1. Press **LF Out Waveform** > **Swept-Sine**.

   This creates a swept-sine output and opens a menu that configures the sweep parameters of the swept-sine signal.

2. Press **LF Out Start Freq** > **100** > **Hz**.

   This sets the swept-sine start frequency to 100 Hz.

3. Press **LF Out Stop Freq** > **1** > **kHz**.

   This sets the swept-sine stop frequency to 1 kHz.

4. Press **Return** > **Return**.

   This returns you to the LF Output menu. The start frequency for the swept-sine waveform is displayed below the **LF Out Freq** softkey.

Configuring the Low Frequency Output

1. Press **LF Out Amplitude** > **3** > **Vp**.

   This sets the LF output amplitude to 3 Vp.

2. Press **LF Out Off On**.

   This activates the LF output. The LF output is a 3 Vp swept-sine waveform, sweeping from 100 Hz to 1 kHz.

4 Digital Modulation for Component Test

cdma2000 Forward Link Modulation

This section teaches you how to build forward link cdma2000 waveforms for testing component designs. The waveforms are generated by the signal generator's internal dual arbitrary waveform generator.

Activating a Predefined CDMA Forward Link State

This procedure teaches you how to perform the following tasks:

- "Selecting a cdma2000 Forward Link Predefined Setup" on page 72
- "Generating the Waveform" on page 72
- "Configuring the RF Output" on page 72

Selecting a cdma2000 Forward Link Predefined Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb CDMA2000**.
3. Press **CDMA2000 Select** > **Pilot**.

This selects a pilot cdma2000 forward link waveform. The display changes to `FWD CDMA2000 Setup: SR1 Pilot`. Forward link is the default setting for link direction, and therefore does not need to be set.

Generating the Waveform

Press **CDMA Off On** until On is highlighted.

This generates the predefined pilot CDMA forward link waveform. During waveform generation, the `CDMA` and `I/Q` annunciators appear and the waveform is stored in volatile Arb memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **2.17** > **GHz**.
2. Press **Amplitude** > **–10** > **dBM**.
3. Press **RF On/Off** until On is highlighted.

The predefined CDMA forward link signal is now available at the RF OUTPUT connector of the signal generator.

Creating a User-Defined CDMA Forward Link State

This procedure teaches you how to perform the following tasks:

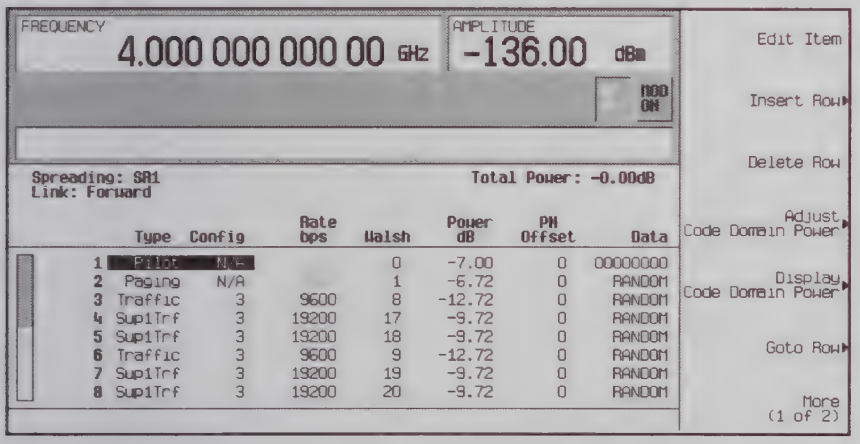
- "Accessing the Table Editor with the Default Forward Link Setup" on page 73
- "Editing cdma2000 Forward Link Channel Parameters" on page 73
- "Inserting Additional cdma2000 Forward Link Traffic Channels" on page 75

Accessing the Table Editor with the Default Forward Link Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Ar b CDMA2000**.
3. Press **More (1 of 2)** > **CDMA200 Define** > **Edit Channel Setup**.

The table editor is now displayed, as shown in Figure 4-1. Notice that the default predefined channel configuration is forward link with 9 channels at spread rate 1. The vertical scroll bar at the side of the screen indicates that there are more rows on the second page. Use the down arrow key to move the cursor to view additional rows.

Figure 4-1


FREQUENCY
4.000 000 000 00 GHz
AMPLITUDE
-136.00 dBm
MOD ON
Spreading: SR1
Link: Forward
Total Power: -0.00dB
Type Config Rate bps Walsh Power dB PN Offset Data
1 Pilot N/A 0 -7.00 0 00000000
2 Paging N/A 1 -6.72 0 RANDOM
3 Traffic 3 9600 8 -12.72 0 RANDOM
4 SupiTrf 3 19200 17 -9.72 0 RANDOM
5 SupiTrf 3 19200 18 -9.72 0 RANDOM
6 Traffic 3 9600 9 -12.72 0 RANDOM
7 SupiTrf 3 19200 19 -9.72 0 RANDOM
8 SupiTrf 3 19200 20 -9.72 0 RANDOM
Edit Item
Insert Row
Delete Row
Adjust Code Domain Power
Display Code Domain Power
Goto Row
More (1 of 2)

Editing cdma2000 Forward Link Channel Parameters

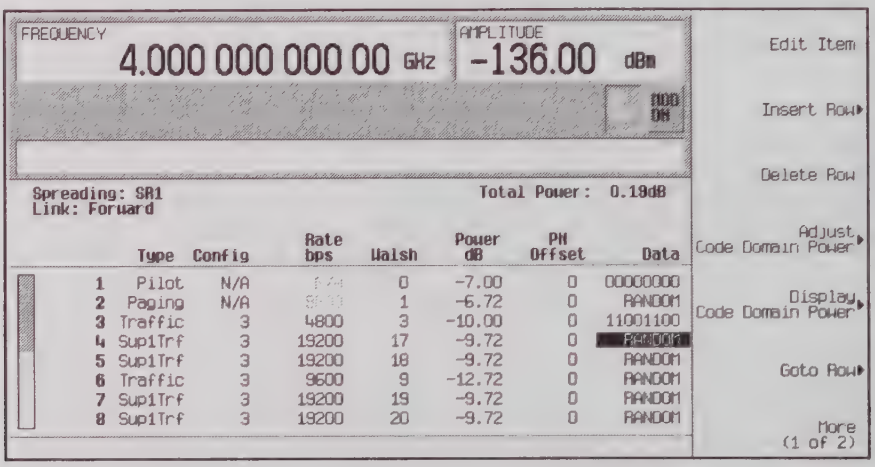
1. Use the arrow keys to move the cursor to the traffic channel located in table row 3.
2. Highlight the `Rate bps` value (`9600`).

3. Press **Edit Item** > **4800**.
4. Highlight the `Walsh` code value (`8`) in table row 3.
5. Press **Edit Item** > **3** > **Enter**.
6. Highlight the `Power` value (`-12.72`) in table row 3.
7. Press **Edit Item** > **-10** > **dB**.

   The display shows that the total power is now at `0.19` dB. You can rescale the total channel power to 0 dB by pressing **Adjust Code Domain Power** > **Scale to 0 dB**.
8. Highlight the `Data` value (`RANDOM`) in table row 3.
9. Press **Edit Item** > **11001100** > **Enter**.

   The forward link channel parameters have now been modified, as shown in Figure 4-2.

Figure 4-2


FREQUENCY
4.000 000 000 00 GHz
AMPLITUDE
-136.00 dBm
Spreading: SR1
Link: Forward
Total Power: 0.19dB
Type Config Rate bps Walsh Power dB PN Offset Data
1 Pilot N/A 0 -7.00 0 00000000
2 Paging N/A 1 -6.72 0 RANDOM
3 Traffic 3 4800 3 -10.00 0 11001100
4 Sup1Trf 3 19200 17 -9.72 0 RANDOM
5 Sup1Trf 3 19200 18 -9.72 0 RANDOM
6 Traffic 3 9600 9 -12.72 0 RANDOM
7 Sup1Trf 3 19200 19 -9.72 0 RANDOM
8 Sup1Trf 3 19200 20 -9.72 0 RANDOM
Edit Item
Insert Row
Delete Row
Adjust Code Domain Power
Display Code Domain Power
Goto Row
More (1 of 2)

10. Press **Return**.

The text area displays `FWD CDMA2000 Setup: SR1 9 Channel (Modified)` as the current configuration. You now have a modified traffic channel with a data rate of 4800, a Walsh code of 3 and a power level of -10.00 dB transmitting 11001100.

To store a custom cdma2000 state, see "Storing a Custom cdma2000 State to Memory" on page 80.

Inserting Additional cdma2000 Forward Link Traffic Channels

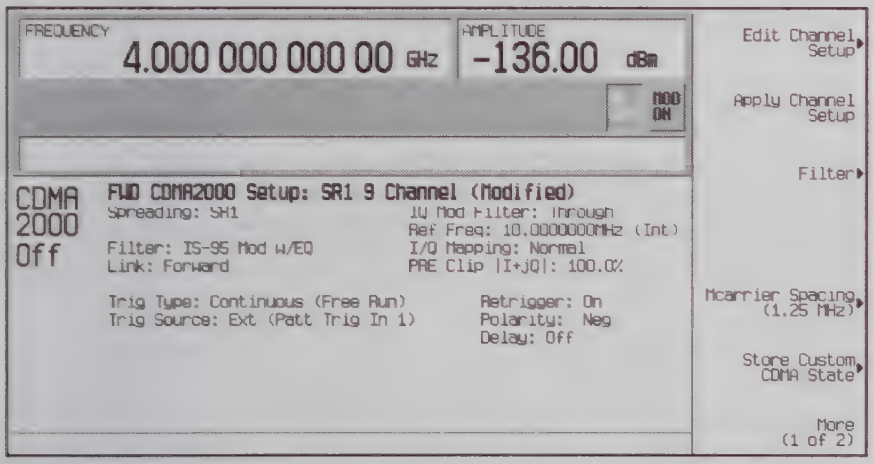
1. Press **Edit Channel Setup**.
2. Move cursor to the bottom row and press **Insert Row** > **Traffic** > **Channels** > **20** > **Enter**.
3. Press **Done**.

The channel table editor now contains the 20 additional channels. The first page displays only channels one through nine. To see the additional channels, press the following key sequence: **Return** > **Goto Row** > **Page Up**.

The display shows that the total power is now at 13.22 dB. You can rescale the total channel power to 0 dB by pressing **Adjust Code Domain Power** > **Scale to 0 dB**.

Press **Return**. The text area displays the current configuration, `FWD CDMA2000 Setup: SR1 9 Channel (Modified)`, as shown in Figure 4-3.

Figure 4-3



To store a custom cdma2000 state, see "Storing a Custom cdma2000 State to Memory" on page 80.

cdma2000 Reverse Link Modulation

This section teaches you how to build reverse link cdma2000 waveforms for testing component designs. The waveforms are generated by the signal generator's internal dual arbitrary waveform generator.

Activating a Predefined cdma2000 Forward Link State

This procedure teaches you how to perform the following tasks:

- "Selecting a Predefined cdma2000 Reverse Link Setup" on page 76
- "Generating the Waveform" on page 76
- "Configuring the RF Output" on page 76

Selecting a Predefined cdma2000 Reverse Link Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb CDMA2000**.
3. Press **Link Forward Reverse** until Reverse is highlighted.
4. Press **CDMA2000 Select** > **Pilot**.

This selects a pilot cdma2000 reverse link waveform. The display changes to `FWD CDMA2000 Setup: SR1 Pilot`.

Generating the Waveform

Press **CDMA Off On** until On is highlighted.

This generates the predefined pilot cdma2000 reverse link waveform. During waveform generation, the `CDMA` and `I/Q` annunciators appear and the waveform is stored in volatile Arb memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **2.17** > **GHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off** until On is highlighted.

The predefined cdma2000 reverse signal is now available at the RF OUTPUT connector of the signal generator.

Creating a User-Defined cdma2000 Reverse Link State

This procedure teaches you how to perform the following tasks:

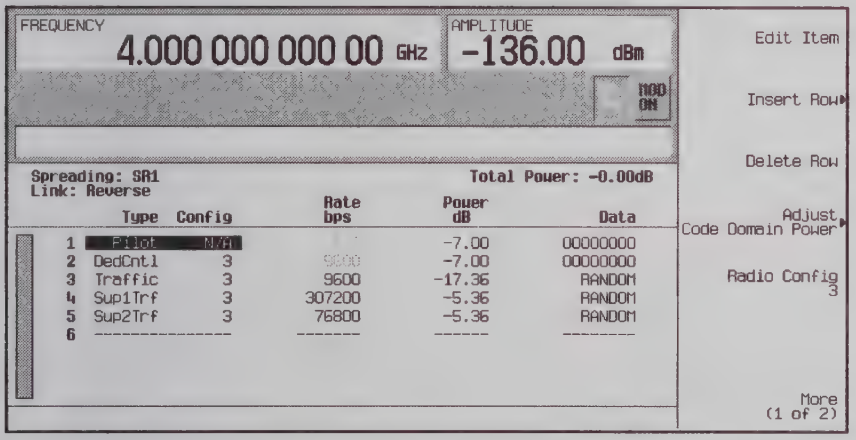
- "Accessing the Table Editor with the Default Reverse Link Setup" on page 77
- "Editing cdma2000 Reverse Link Channel Parameters" on page 77
- "Inserting Additional cdma2000 Reverse Link Traffic Channels" on page 78

Accessing the Table Editor with the Default Reverse Link Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb CDMA2000**.
3. Press **Link Forward Reverse** until Reverse is highlighted.
4. Press **More (1 of 2)** > **CDMA200 Define** > **Edit Channel Setup**.

The table editor is now displayed, as shown in Figure 4-4. Notice that the default predefined channel configuration is reverse link with 5 channels at spread rate 1.

Figure 4-4



Editing cdma2000 Reverse Link Channel Parameters

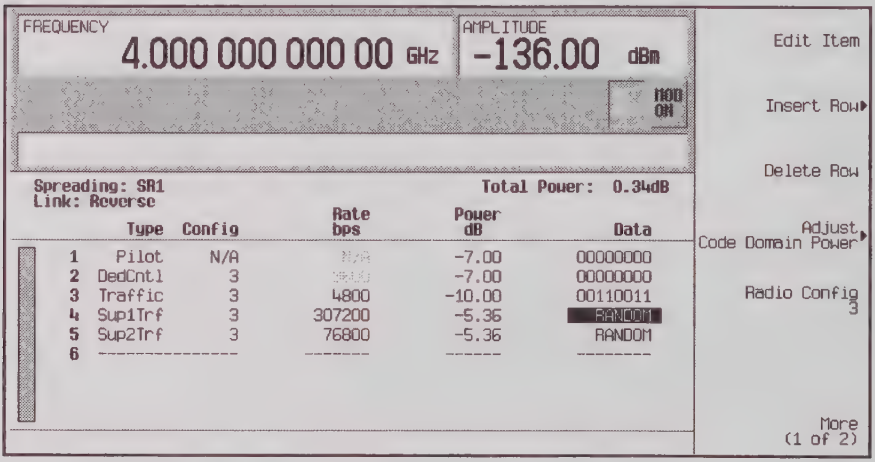
1. Use the arrow keys to move the cursor to the traffic channel located in table row 3.
2. Highlight the `Rate bps` value (`9600`).
3. Press **Edit Item** > **4800**.

4. Highlight the Power value (–17.36) in table row 3.
5. Press **Edit Item** > **–10** > **dB**.

   The display shows that the total power is now at 0.34 dB. You can rescale the total channel power to 0 dB by pressing **Adjust Code Domain Power** > **Scale to 0 dB**.
6. Highlight the Data value (RANDOM) in table row 3.
7. Press **Edit Item** > **00110011** > **Enter**.

   The forward reverse channel parameters have now been modified, as shown in Figure 4-5.

Figure 4-5



8. Press **Return**.

The text area displays RVS CDMA2000 Setup: SR1 5 Channel (Modified) as the current configuration. You now have a modified traffic channel with a data rate of 4800 and a power level of –10.00 dB transmitting 00110011.

To store a custom cdma2000 state, see "Storing a Custom cdma2000 State to Memory" on page 80.

Inserting Additional cdma2000 Reverse Link Traffic Channels

1. Press **Edit Channel Setup**.
2. Move cursor to the bottom row and press **Insert Row** > **Supplemental2 Traffic**.

3. Press **Done**.

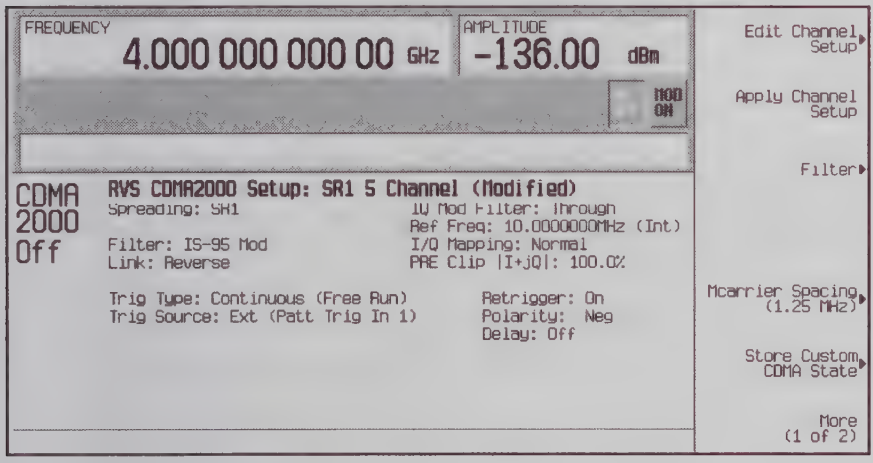
The channel table editor now contains the an additional supplemental2 traffic channel.

The display shows that the total power is now at 1.37 dB. You can rescale the total channel power to 0 dB by pressing **Adjust Code Domain Power** > **Scale to 0 dB**.

Press **Return** > **Return**.

The text area displays the current configuration, `RVS CDMA2000 Setup: SR1 5 Channel (Modified)`, as shown in Figure 4-6.

Figure 4-6



To store a custom cdma2000 state, see "Storing a Custom cdma2000 State to Memory" on page 80.

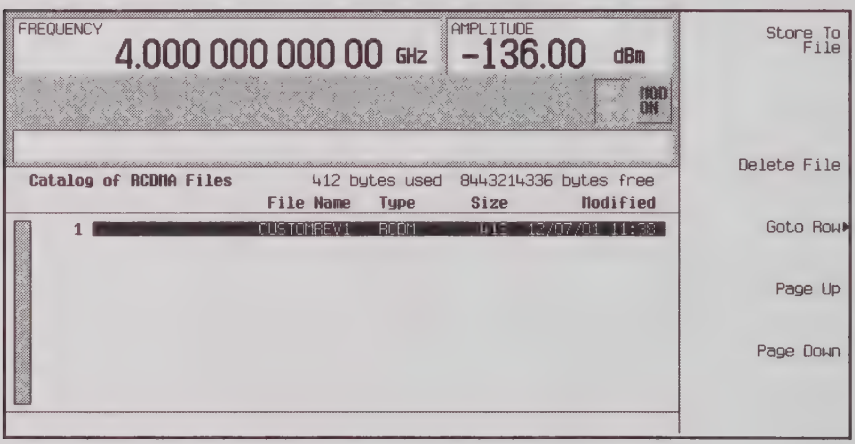
Storing a Custom cdma2000 State to Memory

In this section, you will learn how to store the custom cdma2000 state created in the previous procedure. If you have not performed the previous procedure, turn to "Editing cdma2000 Reverse Link Channel Parameters" on page 77 and complete this procedure before continuing.

Use the following procedure to store the custom cdma2000 state to the memory catalog of the signal generator.

1. Press **Store Custom CDMA State > Store To File**.
2. Using the alphabetic menu and the numeric keypad, enter the file name `CUSTOMREV1`.
3. Press **Enter**.

Figure 4-7



Your custom cdma2000 state `CUSTOMREV1` is now saved to the reverse cdma2000 memory catalog, as shown in Figure 4-7.

Creating, Storing, & Recalling a Custom Multicarrier cdma2000 Waveform

The signal generator provides a quick and easy way to create custom multicarrier cdma2000 waveforms: rather than building an entire 4-carrier setup from scratch, you can start with a 4-carrier cdma2000 template and modify the template's default values as desired.

This section teaches you how to perform the following tasks:

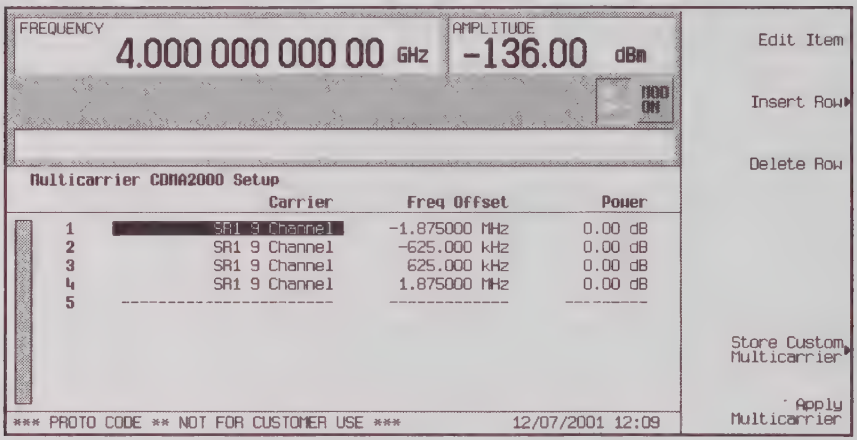
- "Opening the Multicarrier cdma2000 Setup Table Editor" on page 81
- "Modifying a Multicarrier cdma2000 4-Carrier Template" on page 82
- "Activating a Custom Multicarrier cdma2000 Setup" on page 83
- "Storing a Custom Multicarrier cdma2000 Waveform" on page 84
- "Recalling a Custom Multicarrier cdma2000 Waveform" on page 84

Opening the Multicarrier cdma2000 Setup Table Editor

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb CDMA2000** > **Multicarrier Off On** until On is highlighted.
3. Press **CDMA2000 Select** > **4 Carriers**.
4. Press **More (1 of 2)** > **Multicarrier Define.**

This opens the Multicarrier cdma2000 Setup table editor. The 4-carrier cdma2000 template is automatically placed in the table editor, as shown in Figure 4-8 on page 82.

Figure 4-8



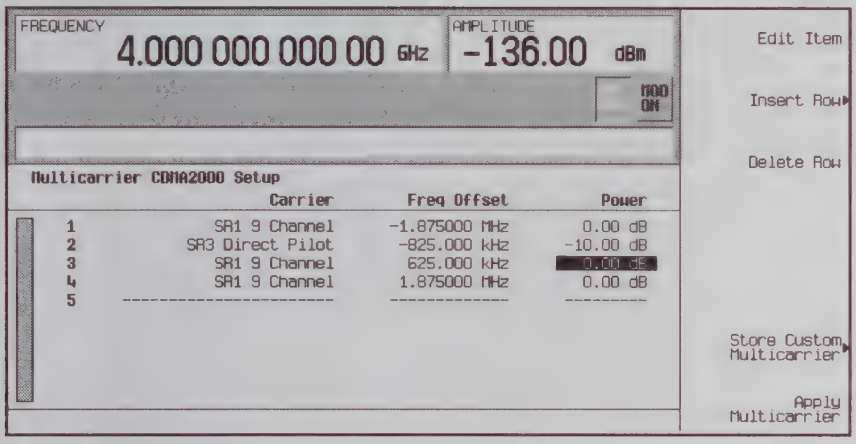
Modifying a Multicarrier cdma2000 4-Carrier Template

Use the tasks to modify the standard 4-carrier cdma2000 template that was loaded in the previous procedure.

1. Highlight the second channel carrier in table row 2.
2. Press **Edit Item > SR3 Direct Pilot**.
3. Highlight the value –625.000 kHz in the `Frequency Offset` field.
4. Press **Edit Item > –825 > kHz**.
5. Highlight the value 0.00 dB in Power field of the second row.
6. Press **Edit Item > –10 > dB**.

This modifies the 4-carrier cdma2000 template, as shown in Figure 4-9 on page 83.

Figure 4-9

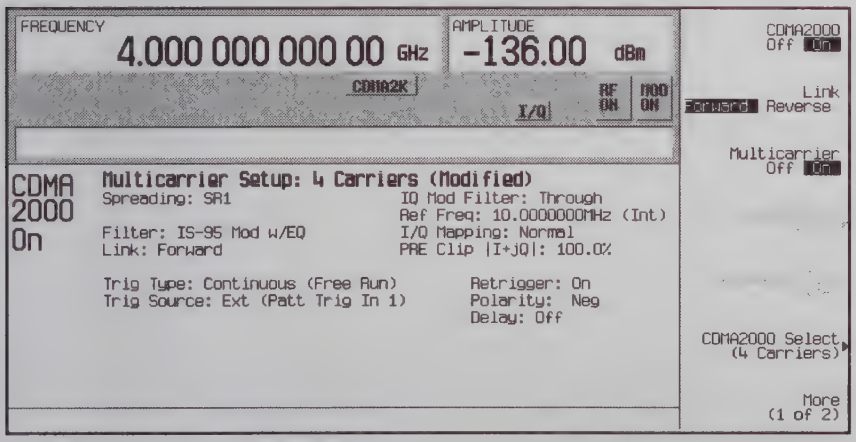


Activating a Custom Multicarrier cdma2000 Setup

Using the custom 4-carrier cdma2000 setup from the previous procedure, perform the following task to activate the custom multicarrier cdma2000 signal.

1. Press **Return** > **More (2 of 2)** > **CDMA2000 Off On** until On is highlighted.
2. Press **RF On/Off**.

Figure 4-10



After waveform generation, the new multicarrier cdma2000 waveform is stored in volatile memory. The CDMA2K and I/Q annunciators appear on the display and the RF ON annunciator replaces the RF OFF annunciator, as shown in the following figure. The modulated signal is now present at the RF OUTPUT connector.

Storing a Custom Multicarrier cdma2000 Waveform

Use the following procedure to store a custom multicarrier cdma2000 waveform into non-volatile memory. This example uses the custom 4-carrier cdma2000 waveform created in the previous procedure. If you have not created this custom multicarrier cdma2000 waveform already, refer to "Creating, Storing, & Recalling a Custom Multicarrier cdma2000 Waveform" on page 81.

1. Press **More (1 of 2)** > **Multicarrier Define**.
2. Press **Store Custom Multicarrier** > **Store To File**.
3. As described in "Storing a Custom Multicarrier cdma2000 Waveform" on page 84, name and store this file as 4CARRIER.

Recalling a Custom Multicarrier cdma2000 Waveform

Use the following procedure to recall a custom multicarrier cdma2000 state from the MFCDMA memory catalog. This example recalls the custom 4-carrier cdma2000 waveform stored in the previous procedure.

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb CDMA2000** > **Multicarrier Off On** until On is highlighted.
3. Press **CDMA2000 Select** > **Custom CDMA2000 Multicarrier**.
4. Highlight the file 4CARRIER, then press **Select File**.

You can now use the waveform. For details, refer to "Activating a Custom Multicarrier cdma2000 Setup" on page 83.

Creating a User-Defined FIR Filter Using the FIR Table Editor

This section teaches you how to perform the following tasks:

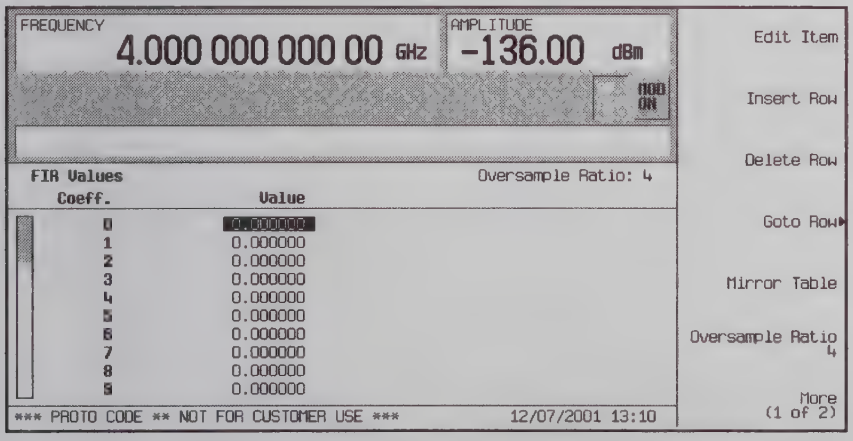
- "Accessing the Table Editor" on page 85
- "Entering the Coefficient Values" on page 86
- "Duplicating the First 16 Coefficients Using Mirror Table" on page 86
- "Setting the Oversample Ratio" on page 87
- "Displaying a Graphical Representation of the Filter" on page 87
- "Storing the Filter to Memory" on page 89

Accessing the Table Editor

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb CDMA2000**.
3. Press **More (1 of 2)** > **CDMA2000 Define** > **Filter** > **Define User FIR**.

This brings up the table editor as shown in Figure 4-11.

Figure 4-11



Entering the Coefficient Values

1. Use the cursor to highlight the `Value` field for coefficient 0, then press **Edit Item**.
2. Use the numeric keypad to type the first value (–0.000076) from Table 4-1. As you press the numeric keys, the numbers are displayed in the active entry area. (If you make a mistake, you can correct it using the backspace key.)
3. Continue entering the coefficient values from the table in step 1 until all 16 values have been entered.

Table 4-1

Coefficient	Value
0	–0.000076
1	–0.001747
2	–0.005144
3	–0.004424
4	0.007745
5	0.029610
6	0.043940
7	0.025852

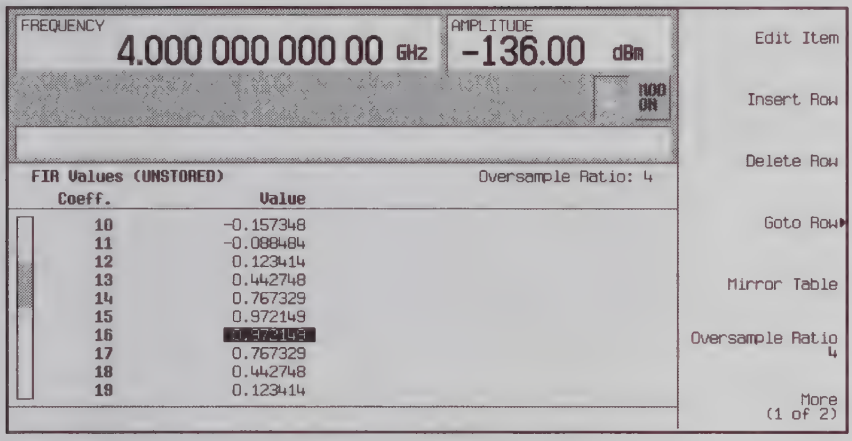
Coefficient	Value
8	–0.035667
9	–0.116753
10	–0.157348
11	–0.088484
12	0.123414
13	0.442748
14	0.767329
15	0.972149

Duplicating the First 16 Coefficients Using Mirror Table

In a windowed sinc function filter, the second half of the coefficients are identical to the first half in reverse order. The signal generator provides a mirror table function that automatically duplicates the existing coefficient values in the reverse order.

1. Press **Mirror Table**. The last 16 coefficients (16 through 31) are automatically generated and the first of these coefficients (number 16) highlights, as shown in Figure 4-12 on page 87.

Figure 4-12



Setting the Oversample Ratio

The oversample ratio (OSR) is the number of filter coefficients per symbol. Acceptable values range from 1 through 32; the maximum combination of symbols and oversampling ratio allowed by the table editor is 1024. The instrument hardware, however, is actually limited to 32 symbols, an oversample ratio between 4 and 16, and 512 coefficients. So if you enter more than 32 symbols or 512 coefficients, the instrument is unable to use the filter. If the oversample ratio is different from the internal, optimally selected one, then the filter is automatically resampled to an optimal oversample ratio.

For this example, the desired OSR is 4, which is the default, so no action is necessary.

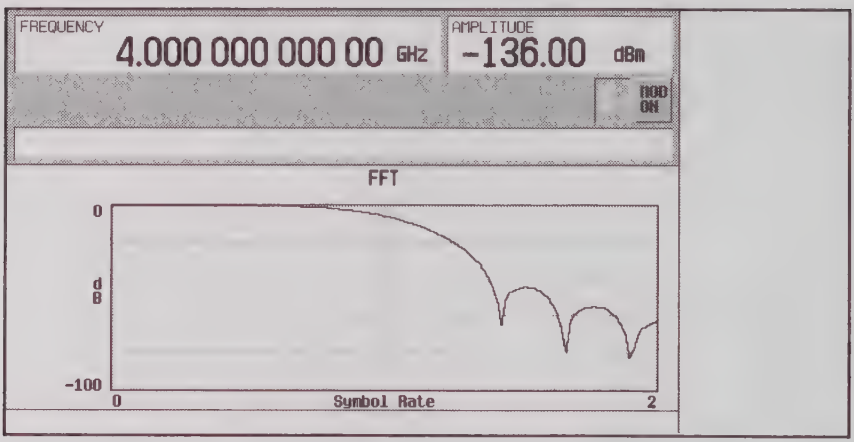
Displaying a Graphical Representation of the Filter

The signal generator has the capability of graphically displaying the filter in both time and frequency dimensions.

1. Press **More (1 of 2)** > **Display FFT** (fast Fourier transform).

   Refer to Figure 4-13 on page 88.

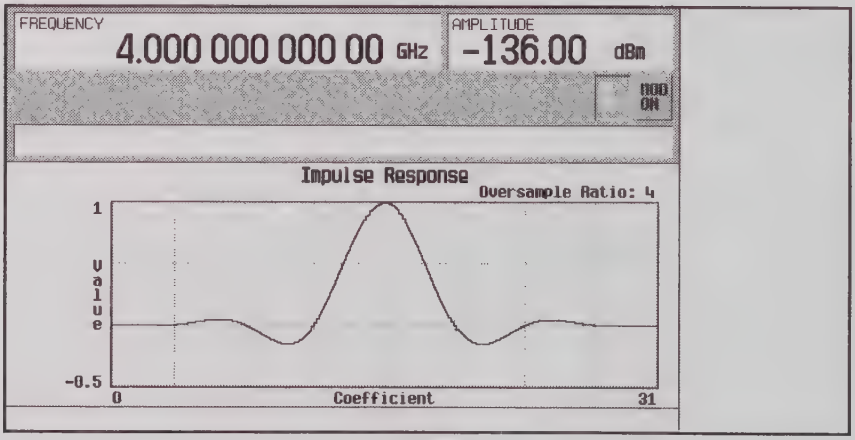
Figure 4-13



2. Press **Return.**
3. Press **Display Impulse Response**.

   Refer to Figure 4-14.

Figure 4-14



4. Press **Return** to return to the menu keys.

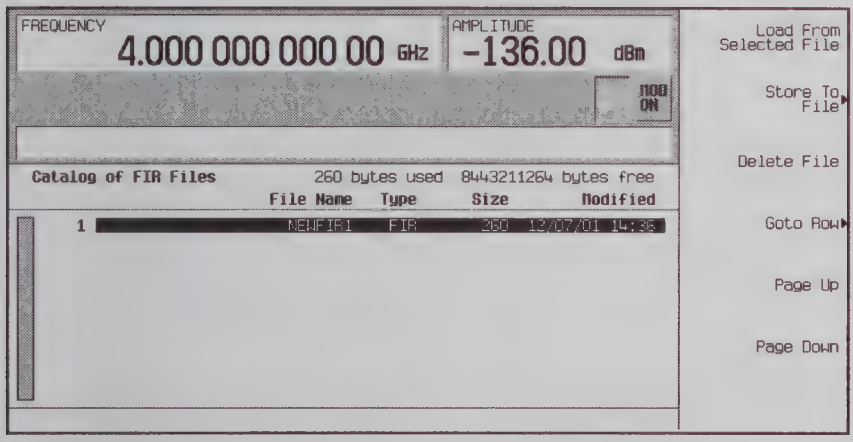
Storing the Filter to Memory

Use the following steps to store the file.

1. Press **Load/Store** > **Store To File**. The catalog of FIR files appears along with the amount of memory available.
2. As described in "Storing a Custom Multicarrier cdma2000 Waveform" on page 84, name and store this file as `NEWFIR1`.

The NEWFIR1 file is the first file name listed. (If you have previously stored other FIR files, additional file names are listed below NEWFIR1.) The file type is FIR and the size of the file is 260 bytes. The amount of memory used is also displayed. The number of files that can be saved depends on the size of the files and the amount of memory used. Refer to Figure 4-15.

Figure 4-15



Memory is also shared by instrument state files and list sweep files.

This filter can now be used to customize a modulation or it can be used as a basis for a new filter design.

Modifying a FIR Filter Using the FIR Table Editor

FIR filters stored in signal generator memory can easily be modified using the FIR table editor. You can load the FIR table editor with coefficient values from user-defined FIR files stored in non-volatile memory or from one of the default FIR filters. Then you can modify the values and store the new files.

This section teaches you how to perform the following tasks:

- "Loading the Default Gaussian FIR File" on page 90
- "Modifying the Coefficients" on page 91
- "Storing the Filter to Memory" on page 92

Loading the Default Gaussian FIR File

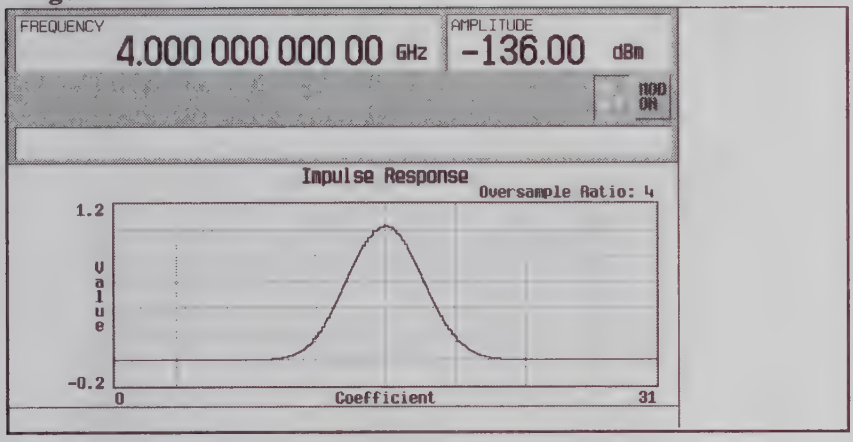
1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb CDMA2000** > **More (1 of 2)** > **CDMA2000 Define**.
3. Press **Filter** > **Define User FIR** > **More (1 of 2)** > **Load Default FIR** > **Gaussian**.
4. Press **Filter BbT** > **0.300** > **Enter**.
5. Press **Filter Symbols** > **8** > **Enter**.
6. Press **Generate**.

NOTE The actual oversample ratio during modulation is automatically selected by the instrument. A value between 4 and 16 is chosen dependent on the symbol rate, the number of bits per symbol of the modulation type, and the number of symbols.

7. Press **Display Impulse Response**

   Refer to Figure 4-16 on page 91.

Figure 4-16

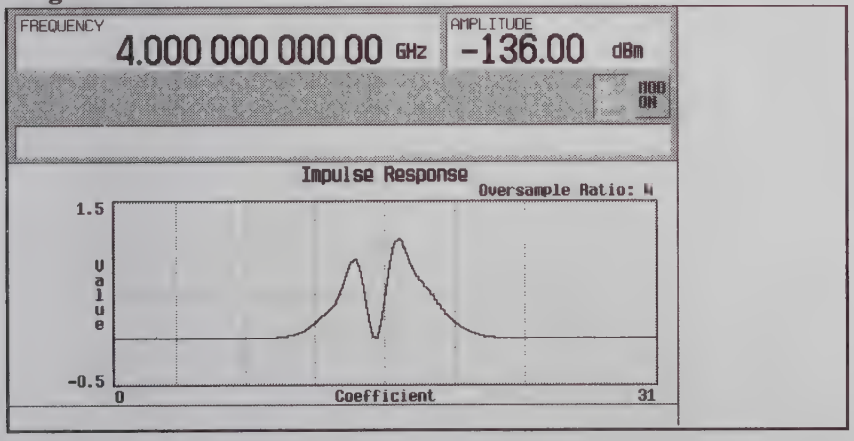


8. Press **Return**.

Modifying the Coefficients

1. Highlight coefficient 15.
2. Press **0** > **Enter**.
3. Press **Display Impulse Response**.

Figure 4-17



Refer to Figure 4-17 on page 91. The graphic display can provide a useful troubleshooting tool (in this case, it indicates that a coefficient value is missing, resulting in an improper Gaussian response).

4. Press **Return**.
5. Press **More (2 of 2)**.
6. Highlight coefficient 15.
7. Press **1** > **Enter**.

Storing the Filter to Memory

1. Press **Load/Store** > **Store To File**.
2. Name the file NEWFIR2.
3. Press **Enter**.

The contents of the current FIR table editor are stored to a file in non-volatile memory and the catalog of FIR files is updated to show the new file.

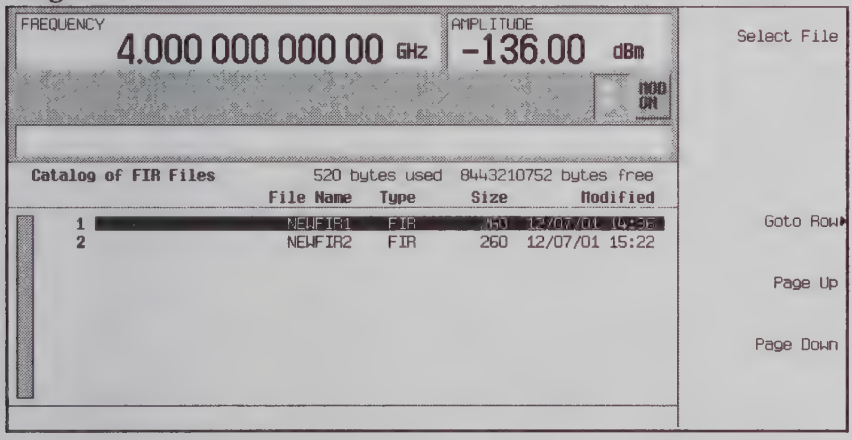
Applying a User-Defined FIR Filter to a cdma2000 Waveform

Custom FIR filters can be created using the FIR table editor feature or they can be created externally and downloaded into signal generator memory. Once a filter is stored in memory, you can select it for use with a custom modulation state. This example requires that at least one FIR file already be stored in memory. For an example of creating and storing a FIR filter, see "Creating a User-Defined FIR Filter Using the FIR Table Editor" on page 85.

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb CDMA2000** > **More (1 of 2)** > **CDMA2000 Define**.
3. Press **Filter** > **Select** > **User FIR**.

   In this example, there are two FIR files listed: NEWFIR1 and NEWFIR2. (These files were created in the previous examples.)

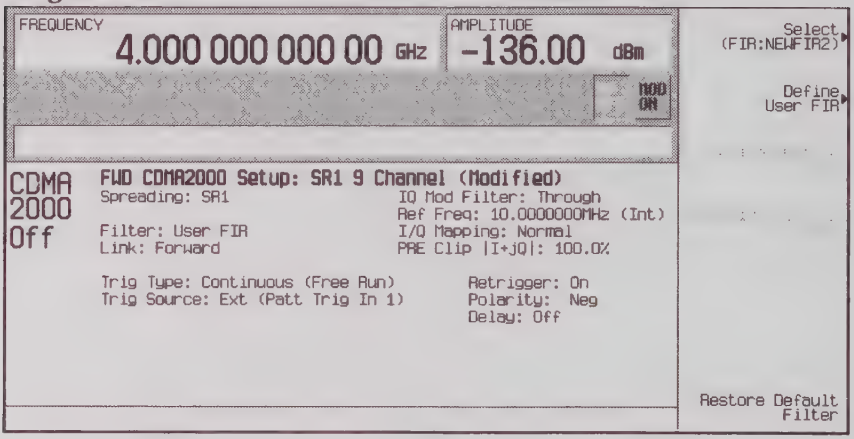
Figure 4-18



4. Scroll down in the list until NEWFIR2 is highlighted.
5. Press **Select File**.

   The highlighted filter is now selected for use in your custom modulation state, as shown in Figure 4-19 on page 94.

Figure 4-19



The filter you selected is NEWFIR2. You can see the name displayed below the **Select** softkey. In the Filter field, near the left of the display, `User FIR` is displayed to indicate that a user-defined FIR filter has been selected.

Once you have set the other modulation parameters to your satisfaction, turn on Custom and the RF output and your user-defined filter is in use.

NOTE The actual oversample ratio during modulation is automatically selected by the instrument. A value between 4 and 16 is chosen dependent on the symbol rate, the number of bits per symbol of the modulation type, and the number of symbols.

W-CDMA Downlink Modulation

This section teaches you how to build W-CDMA downlink waveforms for testing component designs. The waveforms are generated by the signal generator's internal dual arbitrary waveform generator.

Activating a Predefined W-CDMA Downlink State

This procedure teaches you how to perform the following tasks:

- "Selecting a Predefined W-CDMA Setup" on page 95
- "Generating the Waveform" on page 95
- "Configuring the RF Output" on page 95

Selecting a Predefined W-CDMA Setup

1. Press **Preset**.
2. Press **Mode** > **W-CDMA** > **Arb W-CDMA (3GPP 06-2001)**.
3. Press **W-CDMA Select** > **3 DPCH**.

This selects three predefined dedicated physical channels (DPCH) for a downlink waveform. The display changes to `DL WCDMA Setup: 3 DPCH`. Downlink is the signal generator's default setting for link direction and, therefore, does not need to be set.

Generating the Waveform

Press **W-CDMA Off On** until On is highlighted.

This generates the predefined 3 DPCH W-CDMA downlink waveform. During waveform generation, the `WCDMA` and `I/Q` annunciators appear and the waveform is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **2.17** > **GHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off** until On is highlighted.

The predefined W-CDMA downlink signal is now available at the signal generator's RF OUTPUT connector.

Creating a User-Defined W-CDMA Downlink State

This procedure teaches you how to perform the following tasks:

- "Selecting a W-CDMA Downlink Setup" on page 96
- "Editing Downlink Channel Parameters" on page 97
- "Inserting Additional Channels" on page 99
- "Clipping the Waveform" on page 99
- "Generating the Waveform" on page 99
- "Applying Channel Modifications to an Active Waveform" on page 100
- "Configuring the RF Output" on page 100

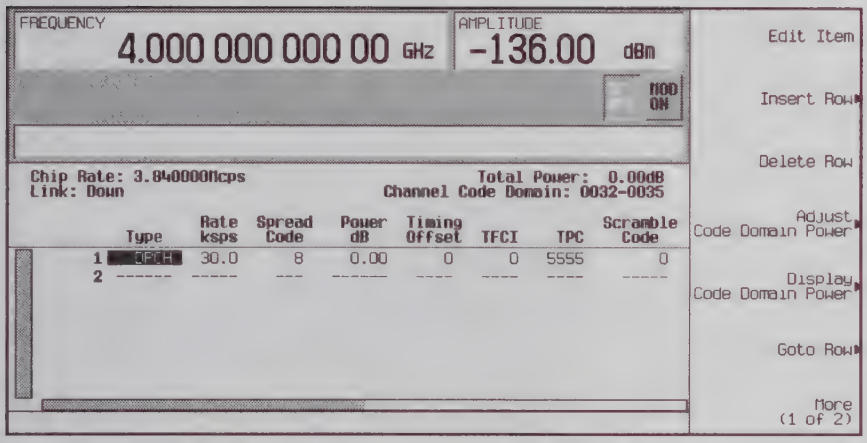
CAUTION Unless previously saved to the signal generator's non-volatile memory, modifications made to predefined channel configurations are lost when changes are made to link direction.

To store a custom W-CDMA state, see "Storing a W-CDMA Downlink State" on page 100.

Selecting a W-CDMA Downlink Setup

1. Press **Preset**.
2. Press **Mode** > **W-CDMA** > **Arb W-CDMA (3GPP 06-2001)**.
3. Press **W-CDMA Define** > **Edit Channel Setup**.

The channel table editor is now displayed, as shown in the following figure. Notice that a dedicated physical channel (DPCH) with predefined parameters is the default setup. The horizontal scroll bar at the bottom of the screen indicates that there are more columns to the right of the `Scramble Code` column. Use the front panel knob or right arrow key to move the cursor to view the additional columns.



Editing Downlink Channel Parameters

1. Use the front panel knob or arrow keys to move the cursor to table row 1.
2. Highlight the `TPC` value (`5555`).
3. Press **Edit Item** > **00FF** > **Enter**.

   The TPC value has now been modified and the cursor has moved to the next row in the `TPC` column.

NOTE TPC values are entered as hexadecimal digits. For information on what these values represent, refer to "Understanding TPC Values" on page 280.

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4. Highlight the value (`0.00`) in the `TFCI Power dB` field, which is currently hidden from view.

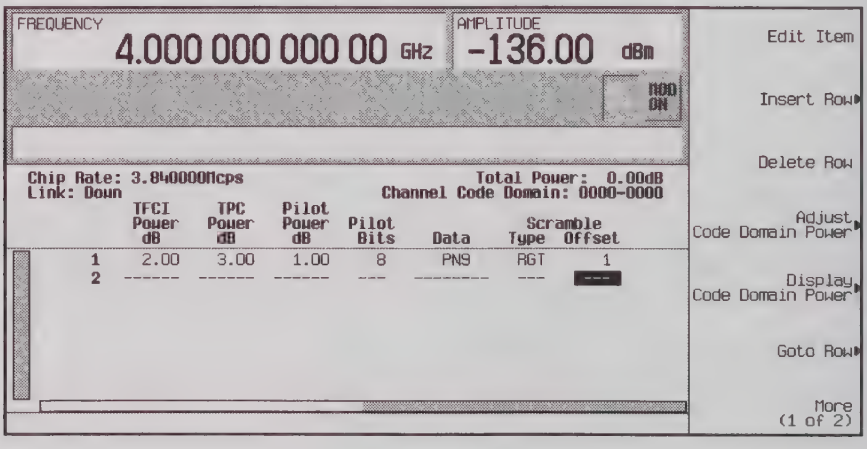
   The horizontal scroll bar at the bottom of the screen indicates that there are columns to the right of the `Scramble Code` column.
5. Press **Edit Item** > **2** > **dB**.
6. Highlight the value (`0.00`) in the `TPC Power dB` field.
7. Press **Edit Item** > **3** > **dB**.
8. Highlight the value (`0.00`) in the `Pilot Power dB` field.
9. Press **Edit Item** > **1** > **dB**.

NOTE For additional information on TFCI, TPC, and pilot power offsets, refer to "Understanding TFCI, TPC, and Pilot Power Offsets" on page 281.

10. Highlight the value (4) in the `Pilot Bits` field.
11. Press **Edit Item** > **8**.
12. Highlight the value (RANDOM) in the `Data` field.
13. Press **Edit Item** > **PN9**.
14. Highlight the value (STD) in the `Scramble Type` field.
15. Press **Edit Item** > **Right Alternate**.
16. Highlight the value (0) in the `Scramble Offset` field.
17. Press **Edit Item** > **1** > **Enter**.

NOTE For additional information on Scramble Type and Scramble Offset, refer to "Calculating Downlink Scramble Codes" on page 283.

The downlink DPCH channel parameters have now been modified, as shown. Other channel parameters can be modified in the same manner.

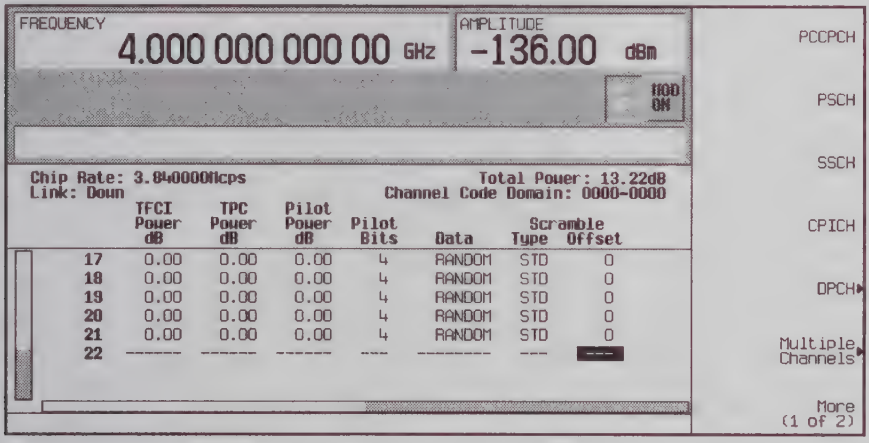


Inserting Additional Channels

Press **Insert Row** > **More (1 of 2)** > **Multiple Channels** > **Channels** > **20** > **Enter** > **Done**.

The channel table editor now contains 20 additional channels, as shown in the following figure. The page only displays six channels. To view the additional channels, press the following keys:

Return > **Goto Row** > **Page Up**.



Clipping the Waveform

1. Press **Return** > **Return** > **More (1 of 2)** > **Clipping**.
2. Press **Clip |I+jQ| To** > **80** > **%**.

The waveform is now set to be clipped at 80 percent of its peak value.

NOTE If the waveform is active (**W-CDMA Off On** set to On), clipping settings are *not* applied until you press the **Apply To Waveform** softkey.

Generating the Waveform

Press **Return** > **Return** > **W-CDMA Off On** until On is highlighted.

This generates a waveform with the custom W-CDMA downlink state created in the previous sections. The display changes to `DL WCDMA Setup: 1 DPCH (Modified)`. Note that 1 DPCH

refers to the predefined configuration, not the number of channels in the user-modified waveform.

During waveform generation, the WCDMA and I/Q annunciators appear and the waveform is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

For instructions on storing this user-defined W-CDMA state to the signal generator's non-volatile memory, see "Storing a W-CDMA Downlink State" on page 100.

Applying Channel Modifications to an Active Waveform

To apply channel modifications to an active waveform (**W-CDMA Off On** set to On), you must press the **Apply Channel Setup** softkey to force the updated waveform to generate. For example, perform the following steps:

1. Press **W-CDMA Define** > **Edit Channel Setup**.
2. Move the cursor to row 2.
3. Press **Delete Row** > **Return** > **Apply Channel Setup**.

Notice that the waveform is regenerated to include the modification of the deleted row. Any changes made in the Edit Channel Setup table editor while a waveform is active will not be applied until the **Apply Channel Setup** softkey is pressed.

Configuring the RF Output

1. Press **Frequency** > **2.17** > **GHz**.
2. Press **Amplitude** > **-10** > **dBm**.
3. Press **RF On/Off** until On is highlighted.

The custom W-CDMA downlink signal is now available at the signal generator's RF OUTPUT connector.

Storing a W-CDMA Downlink State

This procedure teaches you how to store a user-defined W-CDMA state. If you have not created a W-CDMA state, complete the steps in the previous section, "Creating a User-Defined W-CDMA Downlink State" on page 96.

1. Press **Mode Setup** to return to the top-level W-CDMA menu, where **W-CDMA Off On** is the first softkey.

2. Press **W-CDMA Define** > **Store Custom W-CDMA State** > **Store To File**.

   If there is already a file name from the `Catalog of DWCDMA Files` occupying the active entry area, press the following keys:

   Editing Keys > **Clear Text**.

3. Enter a file name (for example, `CUSTOMDN1`) using the alpha softkeys and the numeric keypad.

4. Press **Enter**.

The user-defined W-CDMA downlink state is now stored in non-volatile memory and the file name is listed in the `Catalog of DWCDMA Files`. Note that the actual waveform is not stored; the parameters for generating the signal are stored. The RF output amplitude, frequency, and operating state settings are not stored as part of a user-defined W-CDMA state file.

Recalling a W-CDMA Downlink State

This procedure teaches you how to recall a W-CDMA state from the signal generator's non-volatile memory.

If you have not created and stored a W-CDMA state, complete the steps in the previous sections, "Creating a User-Defined W-CDMA Downlink State" on page 96 and "Storing a W-CDMA Downlink State" on page 100, then preset the signal generator to clear the stored CDMA waveform from volatile ARB memory.

1. Press **Mode** > **W-CDMA** > **Arb W-CDMA (3GPP 06-2001)**.

2. Press **W-CDMA Select** > **Custom W-CDMA State**.

3. Highlight the desired file (for example, `CUSTOMDN1`).

4. Press **Select File**.

5. Press **W-CDMA Off On** until On is highlighted.

The firmware generates the user-defined W-CDMA waveform in volatile ARB memory. The waveform is now modulating the RF carrier.

For instruction on configuring the RF output, see "Configuring the RF Output" on page 100.

Creating a User-Defined Multicarrier W-CDMA State

This procedure teaches you how to perform the following tasks:

- "Selecting a Multicarrier W-CDMA Setup" on page 102
- "Adding a Carrier" on page 102
- "Modifying Carrier Parameters" on page 102
- "Clipping the Multicarrier Waveform" on page 103
- "Generating the Waveform" on page 103
- "Applying Modifications to an Active Multicarrier Waveform" on page 104
- "Configuring the RF Output" on page 104

Selecting a Multicarrier W-CDMA Setup

1. Press **Preset**.
2. Press **Mode** > **W-CDMA** > **Arb W-CDMA (3GPP 06-2001)**.
3. Press **Multicarrier Off On** > **Multicarrier Define**.

The `Multicarrier WCDMA 3GPP Setup` table editor is now displayed, showing parameters for the default two-carrier setup.

Adding a Carrier

1. Highlight the `PCCPCH + SCH` carrier in table row 2.
2. Press **Insert Row** > **3 DPCH**.

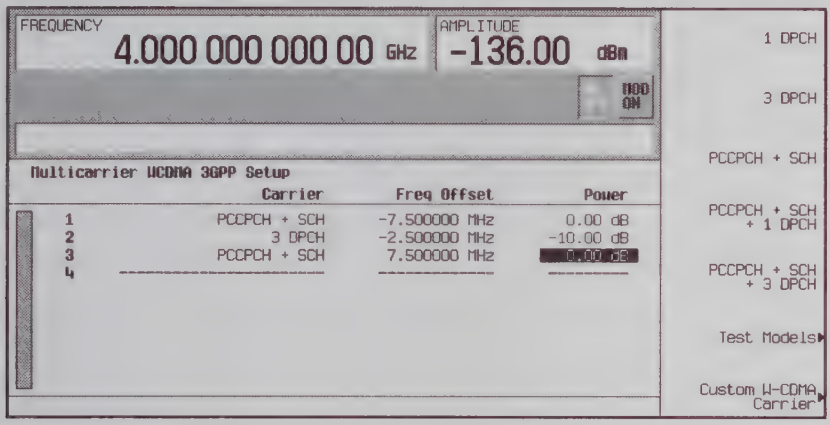
This adds a predefined 3 DPCH carrier between the two original default carriers. You can also add a custom W-CDMA carrier that has been previously created and stored.

Modifying Carrier Parameters

1. Press **Return**.
2. Highlight the `Freq Offset` value (`7.500000 MHz`) for the new 3 DPCH carrier in row 2.
3. Press **Edit Item** > **-2.5** > **MHz**.
4. Highlight the `Power` value (`0.00 dB`) for the new 3 DPCH carrier in row 2.
5. Press **Edit Item** > **-10** > **dB**.

You now have a user-defined 3-carrier W-CDMA waveform with a 3 DPCH carrier at a

frequency offset of -2.5 MHz and a power level of -10.00 dBm, as shown in the following figure.



Clipping the Multicarrier Waveform

1. Press **Return** > **More (1 of 2)** > **Clipping**.
2. Press **Clip |I+jQ| To** > **80** > **%**.

The composite multicarrier waveform is now set to be clipped at 80 percent of its original peak value. The waveform is clipped after FIR filtering.

NOTE If the waveform is active (**W-CDMA Off On** set to On), clipping settings are *not* applied until you press the **Apply Multicarrier** softkey.

Generating the Waveform

Press **Return** > **Return** > **W-CDMA Off On** until On is highlighted.

This generates a waveform with the user-defined multicarrier W-CDMA state created in the previous sections. The display changes to `Multicarrier Setup: 2 Carriers (Modified)`. Note that 2 Carriers refers to the number of carriers in the predefined configuration, not the number of carriers in the user-modified waveform.

During waveform generation, the `WCDMA` and `I/Q` annunciators appear and the waveform is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

For instructions on storing this user-defined multicarrier W-CDMA state to the signal generator's non-volatile memory, see "Storing a Multicarrier W-CDMA State" on page 104.

Applying Modifications to an Active Multicarrier Waveform

1. Press **Multicarrier Define**.
2. Move the cursor to row 2.
3. Press **Delete Row** > **Apply Multicarrier**.

Notice that the waveform is regenerated to include the modification of the deleted row. Any changes made to an active multicarrier waveform will not be applied until the **Apply Multicarrier** softkey is pressed.

Configuring the RF Output

1. Press **Frequency** > **2.17** > **GHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off** until On is highlighted.

The user-defined multicarrier W-CDMA signal is now available at the signal generator's RF OUTPUT connector.

Storing a Multicarrier W-CDMA State

This procedure teaches you how to store a multicarrier W-CDMA state to the signal generator's non-volatile memory.

If you have not created a multicarrier W-CDMA state, complete the steps in the previous section, "Creating a User-Defined Multicarrier W-CDMA State" on page 102.

1. Press **Mode Setup** to return to the top-level W-CDMA menu, where **W-CDMA Off On** is the first softkey.
2. Press **Multicarrier Define** > **Store Custom Multicarrier** > **Store To File**.

   If there is already a file name from the `Catalog of MDWCDMA Files` occupying the active entry area, press the following keys:

   Editing Keys > **Clear Text**.
3. Enter a file name (for example, `3CARRIER`) using the alpha keys and the numeric keypad.
4. Press **Enter**.

The user-defined multicarrier W-CDMA state is now stored in non-volatile memory and the file name is listed in the `Catalog of MDWCDMA Files`. Note that the actual waveform is not stored; the parameters for generating the signal are stored. The RF output amplitude, frequency, and operating state settings are not stored as part of a user-defined W-CDMA state file.

Recalling a Multicarrier W-CDMA State

This procedure teaches you how to recall a multicarrier W-CDMA state from the signal generator's non-volatile memory.

If you have not created and stored a multicarrier W-CDMA state, complete the steps in the previous sections, "Creating a User-Defined Multicarrier W-CDMA State" on page 102 and "Storing a Multicarrier W-CDMA State" on page 104.

1. Press **Preset** to clear the stored W-CDMA waveform from volatile ARB memory.
2. Press **Mode** > **W-CDMA** > **Arb W-CDMA (3GPP 06-2001)**.
3. Press **Multicarrier Off On**.
4. Press **W-CDMA Select** > **Custom W-CDMA Multicarrier**.
5. Highlight the desired file (for example, `3CARRIER`).
6. Press **Select File**.
7. Press **W-CDMA Off On** until On is highlighted.

The firmware generates the selected multicarrier W-CDMA waveform in volatile ARB memory. The waveform is now modulating the RF carrier.

For instruction on configuring the RF output, see "Configuring the RF Output" on page 104.

W-CDMA Uplink Modulation

This section teaches you how to build uplink 3GPP 06-2001 W-CDMA waveforms for testing component designs. The waveforms are generated by the signal generator's internal dual arbitrary waveform generator.

Creating a Predefined W-CDMA Uplink State

This procedure teaches you how to perform the following tasks:

- "Selecting a Predefined W-CDMA Setup" on page 106
- "Generating the Waveform" on page 106
- "Configuring the RF Output" on page 106

Selecting a Predefined W-CDMA Setup

1. Press **Preset**.
2. Press **Mode** > **W-CDMA** > **Arb W-CDMA (3GPP 06-2001)** > **Link Down Up**.
3. Press **W-CDMA Select** > **DPCCH + 3 DPDCH**.

This selects a predefined setup, which consists of one dedicated physical control channel (DPCCH) and three dedicated physical data channels (DPDCH) for an uplink waveform. The display changes to `UL WCDMA Setup: DPCCH + 3 DPDCH`.

Generating the Waveform

Press **W-CDMA Off On** until On is highlighted.

This generates a predefined W-CDMA uplink waveform with a DPCCH and 3 DPDCH channels. During waveform generation, the `WCDMA` and `I/Q` annunciators appear and the waveform is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **2.17** > **GHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off** until On is highlighted.

The predefined W-CDMA uplink signal is now available at the signal generator's RF OUTPUT connector.

Creating a User-Defined W-CDMA Uplink State

This procedure teaches you how to perform the following tasks:

- "Selecting a W-CDMA Uplink Setup" on page 107
- "Editing Uplink Channel Parameters" on page 108
- "Inserting Additional Channels and Modifying I/Q Settings" on page 108
- "Clipping the Waveform" on page 109
- "Generating the Waveform" on page 109
- "Applying Channel Modifications to an Active Waveform" on page 110
- "Configuring the RF Output" on page 110

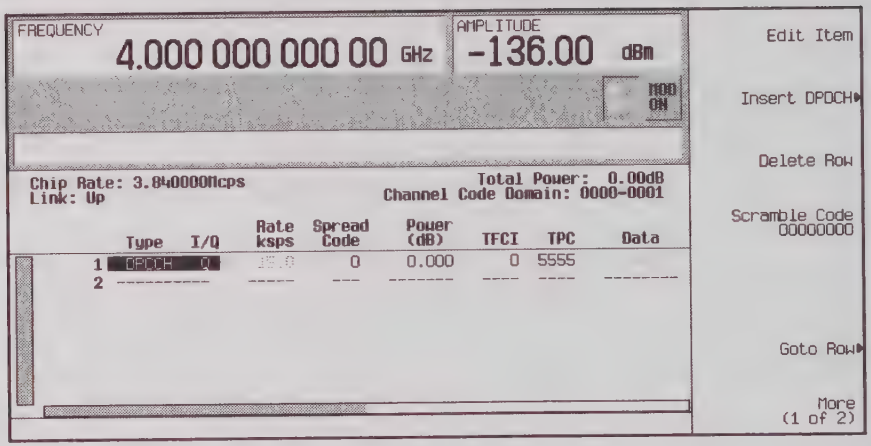
CAUTION Unless previously saved to the signal generator's non-volatile memory, modifications made to predefined channel configurations are lost when changes are made to link direction.

To store a custom W-CDMA state, see "Storing a W-CDMA Uplink State" on page 110.

Selecting a W-CDMA Uplink Setup

1. Press **Preset**.
2. Press **Mode** > **W-CDMA** > **Arb W-CDMA (3GPP 06-2001)** > **Link Down Up**.
3. Press **W-CDMA Define** > **Edit Channel Setup**.

The channel table editor is now displayed, as shown in the following figure. Notice that a dedicated physical control channel (DPCCH) with predefined parameters is the default selection. The horizontal scroll bar at the bottom of the screen indicates that there are more columns to the right of the Data column. Use the front panel knob or right arrow key to move the cursor to view the additional columns.



Editing Uplink Channel Parameters

1. Use the front panel knob or arrow keys to move the cursor to table row 1.
2. Highlight the TPC value (5555).
3. Press **Edit Item** > **00FF** > **Enter**.

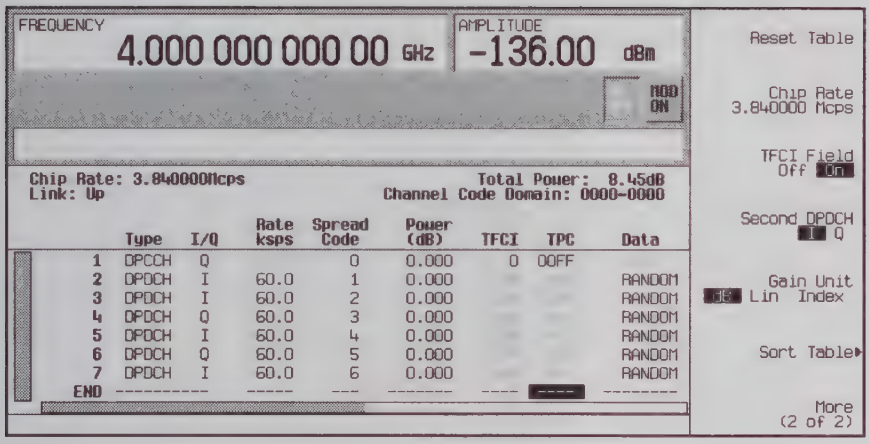
The TPC value has now been modified and the cursor has moved to the next row in the TPC column. Other channel parameters can be modified in the same manner.

NOTE TPC values are entered as hexadecimal digits (0-9, A-F). For information on what these values represent, refer to "Understanding TPC Values" on page 280.

Inserting Additional Channels and Modifying I/Q Settings

1. Press **Insert DPDCH** > **Channels** > **6** > **Enter** > **Done**.
2. Press **More (1 of 2)** > **Second DPDCH I Q** until the letter I is highlighted.

The I/Q setting for the second DPDCH channel (row 3) has changed from Q to I. Additionally, all subsequent channels have also switched I/Q settings, as shown in the following figure.


FREQUENCY
4.000 000 000 00 GHz
AMPLITUDE
-136.00 dBm
MOD ON
Chip Rate: 3.840000Mcps
Link: Up
Total Power: 8.45dB
Channel Code Domain: 0000-0000
Type I/Q Rate ksps Spread Code Power (dB) TFCI TPC Data
1 DPCCH Q 0 0.000 0 OOFF
2 DPDCH I 60.0 1 0.000 RANDOM
3 DPDCH I 60.0 2 0.000 RANDOM
4 DPDCH Q 60.0 3 0.000 RANDOM
5 DPDCH I 60.0 4 0.000 RANDOM
6 DPDCH Q 60.0 5 0.000 RANDOM
7 DPDCH I 60.0 6 0.000 RANDOM
END
Reset Table
Chip Rate 3.840000 Mcps
TFCI Field Off On
Second DPDCH I Q
Gain Unit dB Lin Index
Sort Table
More (2 of 2)

Clipping the Waveform

1. Press **Return** > **More (1 of 2)** > **Clipping**.
2. Press **Clip |I+jQ| To** > **80** > **%**.

The waveform is now set to be clipped at 80 percent of its peak value.

NOTE If the waveform is active (**W-CDMA Off On** set to On), clipping settings are *not* applied until you press the **Apply To Waveform** softkey.

Generating the Waveform

Press **Return** > **Return** > **W-CDMA Off On** until On is highlighted.

This generates a waveform with the custom W-CDMA uplink state created in the previous sections. The display changes to `UL WCDMA Setup: DPCCH (Modified)`. During waveform generation, the `WCDMA` and `I/Q` annunciators appear and the waveform is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

For instructions on storing this custom CDMA state to the signal generator's non-volatile memory, see "Storing a W-CDMA Uplink State" on page 110.

Applying Channel Modifications to an Active Waveform

To apply channel modifications to an active waveform (**W-CDMA Off On** set to On), you must first press the **Apply Channel Setup** softkey before the updated waveform is generated. For example, perform the following steps:

1. Press **W-CDMA Define** > **Edit Channel Setup**.
2. Move the cursor to row 2.
3. Press **Delete Row** > **Return** > **Apply Channel Setup**.

Notice that the waveform is regenerated to include the modification of the deleted row. Any changes made in the Edit Channel Setup table editor while a waveform is active will not be applied until the **Apply Channel Setup** softkey is pressed.

Configuring the RF Output

1. Press **Frequency** > **2.17** > **GHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off** until On is highlighted.

The custom W-CDMA uplink signal is now available at the signal generator's RF OUTPUT connector.

Storing a W-CDMA Uplink State

This procedure teaches you how to store a user-defined W-CDMA state. If you have not created a W-CDMA state, complete the steps in the previous section, "Creating a User-Defined W-CDMA Uplink State" on page 107.

1. Press **Mode Setup** to return to the top-level CDMA menu, where **W-CDMA Off On** is the first softkey.
2. Press **W-CDMA Define** > **Store Custom W-CDMA State** > **Store To File**.

   If there is already a file name from the `Catalog of UWCDMA Files` occupying the active entry area, press the following keys:

   Editing Keys > **Clear Text**.
3. Enter a file name (for example, `CUSTOMUP1`) using the alpha keys and the numeric keypad.
4. Press **Enter**.

The user-defined W-CDMA uplink state is now stored in non-volatile memory and the file name is listed in the `Catalog of UWCDMA Files`. Note that the actual waveform is not stored;

the parameters for generating the signal are stored. The RF output amplitude, frequency, and operating state settings are not stored as part of a user-defined W-CDMA state file.

Recalling a W-CDMA Uplink State

This procedure teaches you how to recall a W-CDMA state from the signal generator's non-volatile memory.

If you have not created and stored a W-CDMA state, complete the steps in the previous sections, "Creating a User-Defined W-CDMA Uplink State" on page 107 and "Storing a W-CDMA Uplink State" on page 110.

1. Press **Preset** to clear the stored W-CDMA waveform from volatile ARB memory.
2. Press **Mode** > **W-CDMA** > **Arb W-CDMA (3GPP 06-2001)** > **Link Down Up**.
3. Press **W-CDMA Select** > **Custom W-CDMA State**.
4. Highlight the desired file (for example, `CUSTOMUP1`).
5. Press **Select File**.
6. Press **W-CDMA Off On** until On is highlighted.

The firmware generates the user-defined W-CDMA waveform in volatile ARB memory. The waveform is now modulating the RF carrier.

For instruction on configuring the RF output, see "Configuring the RF Output" on page 110.

IS-95A Modulation

This section teaches you how to build dual arbitrary waveform generated IS-95A CDMA modulation for testing component designs.

Creating a Predefined CDMA State

This section teaches you how to perform the following tasks:

- "Selecting a Predefined CDMA Setup" on page 112
- "Generating the Waveform" on page 112
- "Configuring the RF Output" on page 112

Selecting a Predefined CDMA Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb IS-95A**.
3. Press **Setup Select** > **64 Ch Fwd**.

Generating the Waveform

Press **CDMA Off On**.

This generates a predefined 64 channel forward CDMA waveform. The display changes to `CDMA Setup: 64 Ch Fwd`. During waveform generation, the `CDMA` and `I/Q` annunciators appear and the predefined digital modulation state is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **890.01** > **MHz**.
2. Press **Amplitude** > **-10** > **dBm**.
3. Press **RF On/Off**.

The predefined 64 channel forward CDMA signal is now available at the signal generator's RF OUTPUT connector.

Creating a User-Defined CDMA State

In this procedure, you learn how to customize a predefined CDMA setup, starting with a forward 32 channel CDMA setup and modifying the setup by adding one channel and changing some of the setup's default values.

This section teaches you how to perform the following tasks:

- "Selecting a CDMA Setup" on page 113
- "Inserting an Additional Channel" on page 113
- "Modifying the Walsh Code" on page 113
- "Modifying the Data" on page 113
- "Modifying the Code Domain Power" on page 114
- "Generating the Waveform" on page 114
- "Configuring the RF Output" on page 114

Selecting a CDMA Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb IS-95A**.
3. Press **Setup Select** > **32 Ch Fwd**.

Inserting an Additional Channel

1. Press **CDMA Define** > **Edit Channel Setup**.
2. Highlight `Traffic` in the `Type` column of row 8.
3. Press **Insert Row** > **Traffic** > **Return**.

Modifying the Walsh Code

1. Highlight the `Walsh` value (`38`) on table row 8.
2. Press **Edit Item** > **45** > **Enter**.

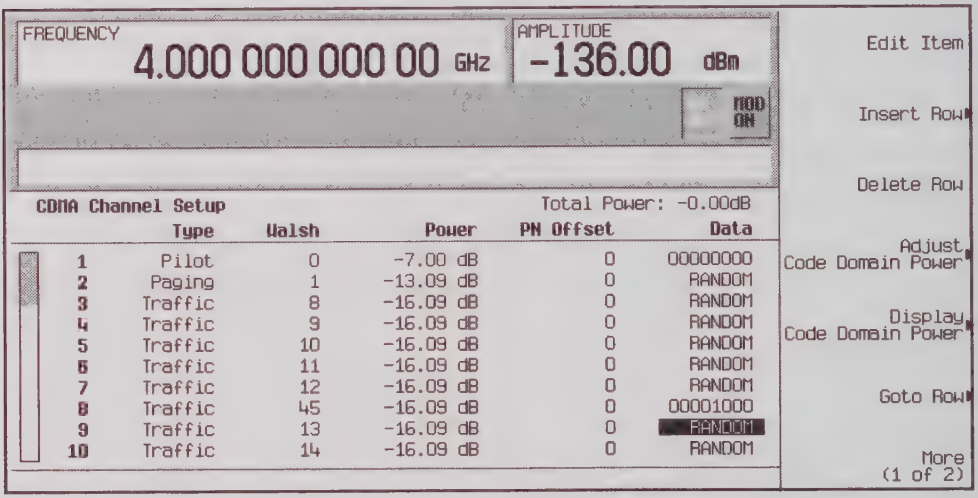
Modifying the Data

1. Highlight the `Data` value (`RANDOM`) on table row 8.
2. Press **Edit Item** > **00001000** > **Enter**.

Modifying the Code Domain Power

Press **Adjust Code Domain Power** > **IS-97 Levels**.

You now have a custom, forward 33 channel CDMA signal at IS-97 power levels, with an inserted traffic channel carrying user-defined data at a Walsh code of 45 on table row 8, as shown in the following figure.


FREQUENCY
4.000 000 000 00 GHz
AMPLITUDE
-136.00 dBm
MOD ON
CDMA Channel Setup
Total Power: -0.00dB
Type Walsh Power PN Offset Data
1 Pilot 0 -7.00 dB 0 00000000
2 Paging 1 -13.09 dB 0 RANDOM
3 Traffic 8 -16.09 dB 0 RANDOM
4 Traffic 9 -16.09 dB 0 RANDOM
5 Traffic 10 -16.09 dB 0 RANDOM
6 Traffic 11 -16.09 dB 0 RANDOM
7 Traffic 12 -16.09 dB 0 RANDOM
8 Traffic 45 -16.09 dB 0 00001000
9 Traffic 13 -16.09 dB 0 RANDOM
10 Traffic 14 -16.09 dB 0 RANDOM
Edit Item
Insert Row
Delete Row
Adjust Code Domain Power
Display Code Domain Power
Goto Row
More (1 of 2)

Generating the Waveform

Press **Return** > **Return** > **CDMA Off On**.

This generates a waveform with the custom CDMA state created in the previous sections. The display changes to `CDMA Setup: 32 Ch Fwd (Modified)`. During waveform generation, the `CDMA` and `I/Q` annunciators appear and the predefined digital modulation state is stored in volatile memory. The waveform is now modulating the RF carrier.

For instructions on storing this custom CDMA state to the non-volatile memory of the signal generator, see "Storing a CDMA State" on page 115.

Configuring the RF Output

1. Press **Frequency** > **890.01** > **MHz**.
2. Press **Amplitude** > **-10** > **dBm**.
3. Press **RF On/Off**.

The custom CDMA signal is now available at the RF OUTPUT connector.

Applying Changes to an Active CDMA State

If the CDMA format is currently in use (**CDMA Off On** set to On) while changes are made in the `CDMA Channel Setup` table editor, you must apply the changes before the updated waveform will be generated.

From the `CDMA Channel Setup` table editor, press the following keys to apply the changes and generate a new user-defined CDMA waveform based on the updated values:

Return > **Apply Channel Setup**.

Storing a CDMA State

In this procedure, you learn how to store a CDMA state. If you have not created a CDMA state, complete the steps in the previous section, "Creating a User-Defined CDMA State" on page 113.

1. Return to the top-level CDMA menu, where **CDMA Off On** is the first softkey.
2. Press **CDMA Define** > **Store Custom CDMA State** > **Store To File**.

   If there is already a file name from the `Catalog of CDMA Files` occupying the active entry area, press the following keys:

   Edit Keys > **Clear Text**
3. Enter a file name (for example, `33CHFWD97`) using the alpha keys and the numeric keypad.
4. Press **Enter**.

The user-defined CDMA state is now stored in non-volatile memory.

NOTE The RF output amplitude, frequency, and operating state settings are not stored as part of a user-defined CDMA state file.

Recalling a CDMA State

Using this procedure, you learn how to recall a CDMA state from non-volatile memory.

If you have not created and stored a CDMA state, complete the steps in the previous sections, "Creating a User-Defined CDMA State" on page 113 and "Storing a CDMA State" on page 115, then preset the signal generator to clear the stored CDMA waveform from volatile memory.

1. Press **Mode** > **CDMA** > **Arb IS-95A**.

2. Press **Setup Select** > **Custom CDMA State**.
3. Highlight the desired file (for example, `33CHFWD97`).
4. Press **Select File**.
5. Press **CDMA Off On** until On is highlighted.

The firmware generates the user-defined CDMA waveform in volatile memory. After waveform generation, the user-defined CDMA state is available to be modulated on the RF output.

For instruction on configuring the RF output, see "Configuring the RF Output" on page 114.

Creating a User-Defined Multicarrier CDMA State

In this procedure, you learn how to customize a predefined multicarrier CDMA setup. Rather than building a 4-carrier setup one carrier at a time, you start with a predefined 3-carrier CDMA setup and modify the setup by adding an additional carrier and changing some of the default values.

This section teaches you how to perform the following tasks:

- "Selecting a Multicarrier CDMA Setup" on page 116
- "Adding a Carrier" on page 116
- "Modifying Carrier Frequency Offset" on page 117
- "Modifying Carrier Power" on page 117
- "Generating the Waveform" on page 117
- "Configuring the RF Output" on page 118

Selecting a Multicarrier CDMA Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb IS-95A**.
3. Press **Multicarrier Off On** > **Multicarrier Define**.

Adding a Carrier

1. Highlight the 9 channel forward carrier in table row 2.
2. Press **Insert Row** > **Pilot** > **Return**.

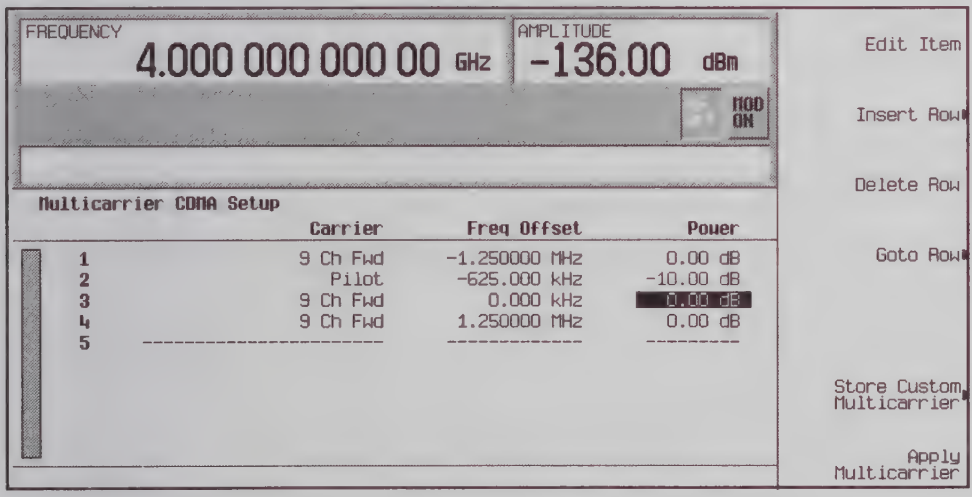
Modifying Carrier Frequency Offset

1. Highlight the `Freq Offset` value (`0.00 kHz`) for the new pilot carrier in row 3.
2. Press **Edit Item > -625 > kHz**.

Modifying Carrier Power

1. Highlight the `Power` value (`0.00 dB`) for the new pilot carrier in row 3.
2. Press **Edit Item > -10 > dB**.

   You now have a user-defined 4-carrier CDMA waveform with an inserted pilot carrier at a frequency offset of -625 kHz and a power level of -10.00 dBm, as shown in the following figure.



Generating the Waveform

Press **Return > CDMA Off On**.

This generates a waveform with the user-defined multicarrier CDMA state created in the previous sections. The display changes to `Multicarrier Setup: 3 Carriers (Modified)`. During waveform generation, the `CDMA` and `I/Q` annunciators appear and the user-defined multicarrier CDMA state is stored in volatile memory. The waveform is now modulating the RF carrier.

For instructions on storing this user-defined multicarrier CDMA state to non-volatile memory, see "Storing a Multicarrier CDMA State" on page 118.

Configuring the RF Output

1. Press **Frequency** > **890.01** > **MHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off**.

The user-defined multicarrier CDMA signal is now available at the RF OUTPUT connector.

Applying Changes to an Active Multicarrier CDMA State

If the CDMA format is currently in use (CDMA Off On set to On) while changes are made in the `Multicarrier CDMA Setup` table editor, you must apply the changes before the updated waveform will be generated.

From the `Multicarrier CDMA Setup` table editor, press the following keys to apply the changes and generate a new user-defined multicarrier CDMA waveform based on the updated values:

Return > **Apply Multicarrier**.

Storing a Multicarrier CDMA State

Using this procedure, you learn how to store a multicarrier CDMA state to the signal generator's memory catalog.

If you have not created a multicarrier CDMA state, complete the steps in the previous section, "Creating a User-Defined Multicarrier CDMA State" on page 116.

1. Return to the top-level CDMA menu, where **CDMA Off On** is the first softkey.
2. Press **Multicarrier Define** > **Store Custom Multicarrier** > **Store To File**.

   If there is already a file name from the `Catalog of MCDMA Files` occupying the active entry area, press the following keys:

   Edit Keys > **Clear Text**
3. Enter a file name (for example, `4CARRIER`) using the alpha keys and the numeric keypad.
4. Press **Enter**.

The user-defined multicarrier CDMA state is now stored in non-volatile memory.

NOTE The RF output amplitude, frequency, and operating state settings are not stored as part of a user-defined CDMA state file.

Recalling a Multicarrier CDMA State

Using this procedure, you learn how to recall a multicarrier CDMA state from the non-volatile memory.

If you have not created and stored a multicarrier CDMA state, complete the steps in the previous sections, "Creating a User-Defined Multicarrier CDMA State" on page 116 and "Storing a Multicarrier CDMA State" on page 118, then preset the signal generator to clear the stored CDMA waveform from volatile memory.

1. Press **Mode** > **CDMA** > **IS-95A**.
2. Press **Multicarrier Off On**.
3. Press **Setup Select** > **Custom CDMA Multicarrier**.
4. Highlight the desired file (for example, `4CARRIER`).
5. Press **Select File**.
6. Press **CDMA Off On** until On is highlighted.

The firmware generates the selected multicarrier CDMA waveform in volatile memory. After waveform generation, the multicarrier CDMA state is available to be modulated on the RF output.

For instruction on configuring the RF output, see "Configuring the RF Output" on page 118.

Custom TDMA Digital Modulation

This section teaches you how to build dual arbitrary waveform generated custom TDMA digital modulation for testing component designs.

Custom dual arbitrary waveform generated digital modulation creates waveforms using the modulation type, filtering, symbol rate, and other parameters defined by individual digital communications standards. These waveforms transmit unframed data.

Using Predefined Custom TDMA Digital Modulation

This section teaches you how to perform the following tasks:

- "Selecting a Predefined EDGE Setup" on page 120
- "Generating the Waveform" on page 120
- "Configuring the RF Output" on page 120

Selecting a Predefined EDGE Setup

1. Press **Preset**.
2. Press **Mode** > **Custom** > **ARB Waveform Generator**.
3. Press **Setup Select** > **EDGE**.

Generating the Waveform

Press **Digital Modulation Off On**.

This generates a waveform with the predefined EDGE state selected in the previous section. The display changes to `Dig Mod Setup: EDGE`. During waveform generation, the `DIGMOD` and `I/Q` annunciators appear and the predefined digital modulation state is stored in volatile memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **891** > **MHz**.
2. Press **Amplitude** > **–5** > **dBm**.
3. Press **RF On/Off**.

The predefined EDGE signal is now available at the signal generator's RF OUTPUT connector.

Creating a Custom TDMA Digital Modulation State

In this procedure, you learn how to set up a single-carrier NADC digital modulation with customized modulation type, symbol rate, and filtering.

This section teaches you how to perform the following tasks:

- "Selecting a Digital Modulation Setup" on page 121
- "Modifying the Modulation Type and Symbol Rate" on page 121
- "Modifying the Filter" on page 121
- "Configuring the RF Output" on page 122

Selecting a Digital Modulation Setup

1. Press **Preset**.
2. Press **Mode** > **Custom** > **ARB Waveform Generator**.
3. Press **Setup Select** > **NADC**.

Modifying the Modulation Type and Symbol Rate

1. Press **Digital Mod Define** > **Modulation Type** > **PSK** > **QPSK and OQPSK** > **QPSK**.
2. Press **Symbol Rate** > **56** > **ksps**.

Modifying the Filter

1. Press **Filter** > **Select** > **Nyquist**.
2. Press **Return** > **Return**.

Generating the Waveform

Press **Digital Modulation Off On**.

This generates a waveform with the custom single-carrier NADC digital modulation state created in the previous sections. The display changes to `Dig Mod Setup: NADC (Modified)`. During waveform generation, the `DIGMOD` and `I/Q` annunciators appear and the custom single-carrier digital modulation state is stored in volatile memory. The waveform is now modulating the RF carrier.

For instructions on storing this custom single-carrier NADC digital modulation state to non-volatile memory catalog, see "Storing a Custom TDMA Digital Modulation State" on page 122.

Configuring the RF Output

1. Press **Frequency** > **835** > **MHz**.
2. Press **Amplitude** > **0** > **dBm**.
3. Press **RF On/Off**.

The user-defined NADC signal is now available at the RF OUTPUT connector.

Storing a Custom TDMA Digital Modulation State

Using this procedure, you learn how to store a custom digital modulation state to non-volatile memory.

If you have not created a custom single-carrier digital modulation state, complete the steps in the previous section, "Creating a Custom TDMA Digital Modulation State" on page 121.

1. Return to the top-level Digital Modulation menu, where **Digital Modulation Off On** is the first softkey.
2. Press **Digital Mod Define** > **Store Custom Dig Mod State** > **Store To File**.

   If there is already a file name from the `Catalog of DMOD Files` occupying the active entry area, press the following keys:

   Edit Keys > **Clear Text**
3. Enter a file name (for example, `NADCQPSK`) using the alpha keys and the numeric keypad.
4. Press **Enter**.

The user-defined single-carrier digital modulation state is now stored in non-volatile memory.

NOTE The RF output amplitude, frequency, and operating state settings are not stored as part of a user-defined digital modulation state file.

Recalling a Custom TDMA Digital Modulation State

Using this procedure, you learn how to recall a custom digital modulation state from signal non-volatile memory.

If you have not created and stored a user-defined single-carrier digital modulation state, complete the steps in the previous sections, "Creating a Custom TDMA Digital Modulation State" on page 121 and "Storing a Custom TDMA Digital Modulation State" on page 122, then preset the signal generator to clear the stored user-defined digital modulation

waveform from volatile ARB memory.

1. Press **Mode** > **Custom** > **ARB Waveform Generator**.
2. Press **Setup Select** > **More (1 of 2)** > **Custom Digital Mod State**.
3. Highlight the desired file (for example, `NADCQPSK`).
4. Press **Select File**.
5. Press **Digital Modulation Off On** until On is highlighted.

The firmware generates the custom digital modulation waveform in volatile memory. After waveform generation, the custom digital modulation waveform is available to be modulated on the RF output.

For instruction on configuring the RF output, see "Configuring the RF Output" on page 122.

Creating a Custom Multicarrier TDMA Digital Modulation State

In this procedure, you learn how to customize a predefined multicarrier digital modulation setup by creating a custom 3-carrier EDGE digital modulation state.

This section teaches you how to perform the following tasks:

- "Creating a Multicarrier Digital Modulation Setup" on page 123
- "Modifying Carrier Frequency Offset" on page 117
- "Modifying Carrier Power" on page 117
- "Generating the Waveform" on page 117
- "Configuring the RF Output" on page 124

Creating a Multicarrier Digital Modulation Setup

1. Press **Preset**.
2. Press **Mode** > **Custom** > **Arb Waveform Generator**.
3. Press **Multicarrier Off On**.
4. Press **Multicarrier Define** > **Initialize Table** > **Carrier Setup** > **EDGE** > **Done**.

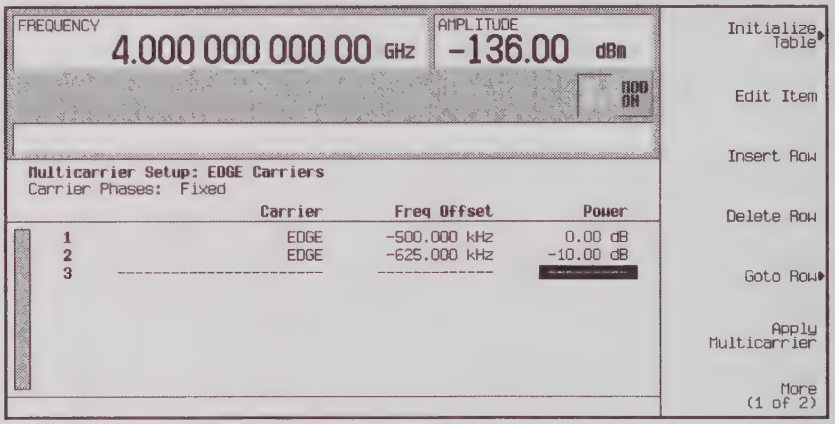
Modifying Carrier Frequency Offset

1. Highlight the `Freq Offset` value (`500.000 kHz`) for the carrier in row 2.
2. Press **Edit Item** > **-625** > **kHz**.

Modifying Carrier Power

1. Highlight the Power value (0.00 dB) for the carrier in row 2.
2. Press **Edit Item** > **-10** > **dB**.

   You now have a custom 2-carrier EDGE waveform with a carrier at a frequency offset of -625 kHz and a power level of -10.00 dBm, as shown in the following figure.



Generating the Waveform

Press **Return** > **Digital Modulation Off On**.

This generates a waveform with the custom multicarrier EDGE state created in the previous sections. The display changes to Dig Mod Setup: Multicarrier (Modified). During waveform generation, the DIGMOD and I/Q annunciators appear and the new custom multicarrier EDGE state is stored in volatile memory. The waveform is now modulating the RF carrier.

For instructions on storing this custom multicarrier EDGE state to non-volatile memory, see "Storing a Custom Multicarrier TDMA Digital Modulation State" on page 125.

Configuring the RF Output

1. Press **Frequency** > **890.01** > **MHz**.
2. Press **Amplitude** > **-10** > **dBm**.
3. Press **RF On/Off**.

The custom multicarrier EDGE signal is now available at the RF OUTPUT connector.

Storing a Custom Multicarrier TDMA Digital Modulation State

Using this procedure, you learn how to store a custom multicarrier TDMA digital modulation state to non-volatile memory.

If you have not created a custom multicarrier digital modulation state, complete the steps in the previous section, "Creating a Custom Multicarrier TDMA Digital Modulation State" on page 123.

1. Return to the top-level Digital Modulation menu, where **Digital Modulation Off On** is the first softkey.
2. Press **Multicarrier Define** > **More (1 of 2)** > **Load/ Store** > **Store To File**.

   If there is already a file name from the `Catalog of MDMOD Files` occupying the active entry area, press the following keys:

   Edit Keys > **Clear Text**
3. Enter a file name (for example, `EDGEM1`) using the alpha keys and the numeric keypad.
4. Press **Enter**.

The user-defined multicarrier digital modulation state is now stored in non-volatile memory.

NOTE The RF output amplitude, frequency, and operating state settings are not stored as part of a user-defined digital modulation state file.

Applying Changes to an Active Multicarrier TDMA Digital Modulation State

If the digital modulation format is currently in use (**Digital Modulation Off On** set to On) while changes are made in the `Multicarrier Setup` table editor, you must apply the changes before the updated waveform will be generated.

From the `Multicarrier Setup` table editor, press **Apply Multicarrier** to apply the changes and generate a new custom multicarrier digital modulation waveform based on the updated values.

5 Digital Modulation for Receiver Test

W-CDMA Downlink Modulation

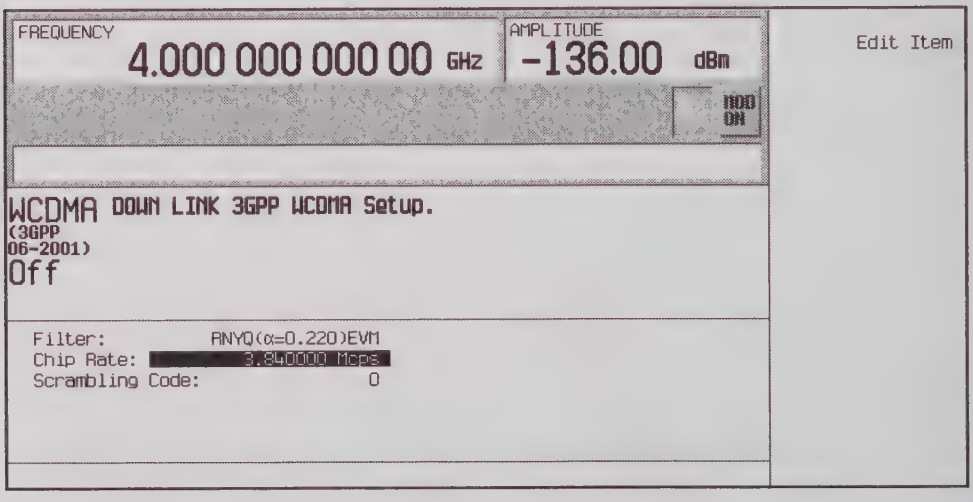
This section teaches you how to build real-time W-CDMA downlink modulation for testing mobile receiver designs. The modulation is generated by the signal generator's internal baseband generator. The procedures in this section build on each other and are designed to be used sequentially.

Configuring the Base Station Setup

1. Press **Preset**.
2. Press **Mode** > **W-CDMA** > **Real Time W-CDMA** > **BS Setup**.

   This opens a menu where you can adjust the filtering type, chip rate, and scrambling code for the simulated base station (see Figure 5-1).

Figure 5-1 Base Station Setup



Use the arrow keys or the knob to highlight the data fields to be edited. Once a field has been highlighted, pressing the **Edit Item** softkey enables you to change the value.

Configuring the Physical Layer

The steps in this procedure build upon the previous procedure.

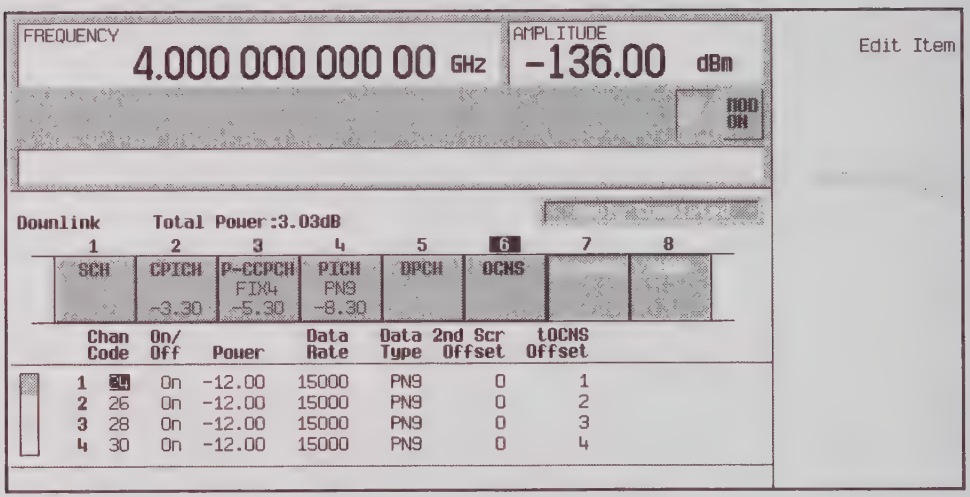
1. Press **Return** > **Link Control** > **5** > **Enter**.
2. Press **PhyCH Setup**.
3. Move the cursor to highlight the `On/Off` value for DPCH data channel 2.
4. Press **Edit Item** to toggle the channel on.

   The data channel state changes each time you press **Edit Item**. You can now move the cursor to edit other data channel fields as well.
5. Press **Return**.
6. Press **Channel State Off On** to Off.

   Notice that toggling the channel state not only turns off or on the selected physical channel (in this case DPCH), but also turns off or on *all* of its data channels, which are shown in the table editor. To turn individual data channels off or on, repeat steps 2 through 4.
7. Press **Channel State Off On** to On.
8. Press **6** > **Enter**. (Or, press the right arrow key.)
9. Press **Channel State On Off** to On > **PhyCH Setup**.

   This activates the OCNS physical channel, turning on all 16 of its data channels, and accesses the table editor. Refer to Figure 5-2.

Figure 5-2 Physical Layer Table Editor


FREQUENCY
4.000 000 000 00 GHz
AMPLITUDE
-136.00 dBm
Edit Item
MOD ON
Downlink Total Power:3.03dB
1 2 3 4 5 6 7 8
SCH
CPICH
P-CCPCH FIX4 -5.30
PICH PN9 -8.30
DPCH
OCNS
-3.30
Chan Code On/ Off Power Data Rate Data Type 2nd Scr Offset tOCNS Offset
1 SCH On -12.00 15000 PN9 0 1
2 26 On -12.00 15000 PN9 0 2
3 28 On -12.00 15000 PN9 0 3
4 30 On -12.00 15000 PN9 0 4

Each data channel can be edited to have different settings, such as different time offsets, as required by 3GPP TS25.101, for performing some of the functional tests.

Use the arrow keys or the knob to highlight the data fields to be edited. Once a field has been highlighted, pressing the **Edit Item** softkey enables you to change the value.

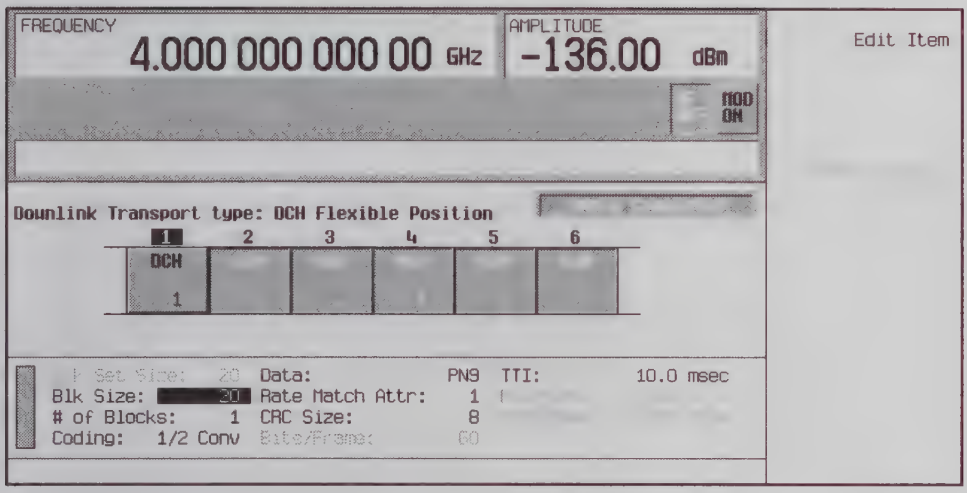
Configuring the Transport Layer

The steps in this procedure build upon the previous procedure.

1. Press **Return > 5 > Enter.** (Or, press the left arrow key.)
2. Press **Transport Setup > TrCH Setup**.

This accesses the Downlink Transport type table editor. Refer to Figure 5-3.

Figure 5-3 Transport Layer Table Editor


FREQUENCY
4.000 000 000 00 GHz
AMPLITUDE
-136.00 dBm
Edit Item
MOD ON
Downlink Transport type: DCH Flexible Position
1 2 3 4 5 6
DCH 1
Set Size: 20 Data: PN9 TTI: 10.0 msec
Blk Size: 30 Rate Match Attr: 1
# of Blocks: 1 CRC Size: 8
Coding: 1/2 Conv Bits/Frame: 60

Use the arrow keys or the knob to highlight the data fields to be edited. Once a field has been highlighted, pressing the **Edit Item** softkey enables you to change the value.

Adjusting Code Domain Power

The tasks in this procedure build upon the previous procedure. This procedure teaches you how to perform the following tasks:

- "Scaling to 0 dB" on page 132
- "Setting Equal Channel Powers" on page 133

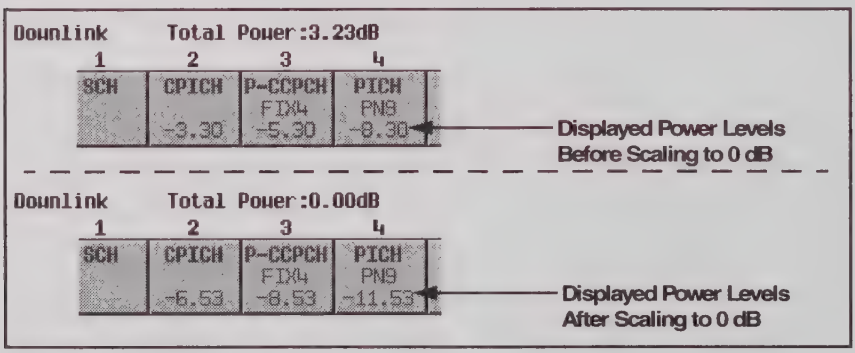
Scaling to 0 dB

After changing the relative power level for a channel, the ESG automatically scales the total power to 0 dB, while preserving the relative channel power levels. Although the displayed total power changes in value as channel powers are adjusted, the actual total power is maintained at 0 dB. The displayed channel power levels remain unchanged, reflecting only user-assigned values, so the user can complete the relative power adjustments. This task teaches you how to update the display to show the normalized relative channel power for each channel after completing the setup.

1. Press **Mode Setup** to return to the top-level real-time W-CDMA menu.
2. Press **Link Control** > **Adjust Code Domain Power** > **Scale to 0 dB**.

The power level displayed for each channel is now changed to show the normalized relative channel power. The values shown in Figure 5-4 result from activating the OCNS channel, as described earlier in this section. Notice the displayed power levels before and after the **Scale to 0 dB** softkey is pressed.

Figure 5-4 Scaling to Zero dB



Setting Equal Channel Powers

This task teaches you how to set the relative power level for all active channels to be equal, for a total power level of 0 dB. The normalized relative power level of each channel depends on the number of active channels. This task is an alternative to scaling to 0 dB.

Press **Adjust Code Domain Power** > **Equal Powers**.

All active channels have now been set to equal powers. Figure 5-5 shows the displayed normalized relative power levels after the **Equal Powers** softkey is pressed with seven active channels. Notice also that the displayed total power shows a residual value of `0.02 dB` due to decimal rounding.

Figure 5-5 Equal Powers

Managing Noise

The tasks in this procedure build upon the previous procedure.

The following tasks teach you how to set the overall carrier-to-noise (C/N) ratio for the downlink W-CDMA setup and to set the EcNo value for individual physical channels.

- "Setting the Carrier to Noise Ratio" on page 133
- "Setting EcNo" on page 134

Setting the Carrier to Noise Ratio

1. Press **Mode Setup** to return to the top-level real-time W-CDMA menu.
2. Press **Link Control** > **8** > **Enter** > **Channel State Off On** to On.
3. Press **PhyCH Setup**.
4. Move the cursor to highlight the `C/N value` field.
5. Press **10** > **dB**.

NOTE Noise values less than 10 dB may not be visible on a spectrum analyzer.

You have now set the overall carrier to noise ratio to 10 dB and turned on noise. This is done to apply a discernible level of noise across the entire channel space.

Setting EcNo

1. Move the cursor to highlight the `Ec Ref` field.
2. Press **Edit Item** > **DPCH 2**.
3. Move the cursor to highlight the `Ec/No value` field.
4. Press **15** > **dB**.

NOTE Noise values less than 10 dB may not be visible on a spectrum analyzer.

You have now set the EcNo value for the DPCH 2 channel to 15 dB. Note that modifying the EcNo value for a channel will change the overall carrier to noise ratio and the EcNo value for all other active channels. For reliable results when making hand calculations to determine or verify EcNo values, it is recommended that you first scale the code domain power to 0 dB to display the normalized relative channel power levels (see "Scaling to 0 dB" on page 132).

Generating the Baseband Signal

This procedure builds upon the previous procedure.

Press **Mode Setup** > **W-CDMA Off On** to On.

This generates the real-time downlink W-CDMA signal. The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `WCDMA On` and the `WCDMA` and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

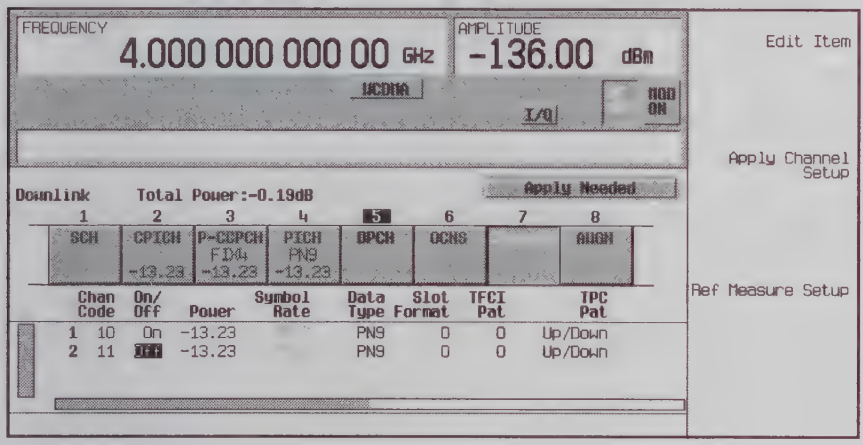
Applying New Settings

The steps in this procedure build upon the previous procedure.

1. Press **Link Control** > **5** > **Enter**.
2. Press **PhyCH Setup**.
3. Move the cursor to highlight the `On/Off` value for DPCH data channel 2.
4. Press **Edit Item** to toggle the channel off.

Notice that with the personality already turned on, as soon as a data channel parameter is changed, the `Apply Needed` annunciator appears (see Figure 5-6). This indicates that the new setting has not yet taken effect in the active baseband signal.

Figure 5-6 Display Indicates that Apply is Needed



5. Press **Apply Channel Setup**.

The new setting to the DPCH data channel is now applied to the baseband signal. Notice also that the `Apply Needed` annunciator is replaced with `Apply Completed`.

Configuring the RF Output

The steps in this procedure build upon the previous procedure.

1. Press **Frequency** > **2.11** > **GHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined, real-time downlink W-CDMA signal is now available at the RF OUTPUT connector of the signal generator.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

W-CDMA Uplink Modulation

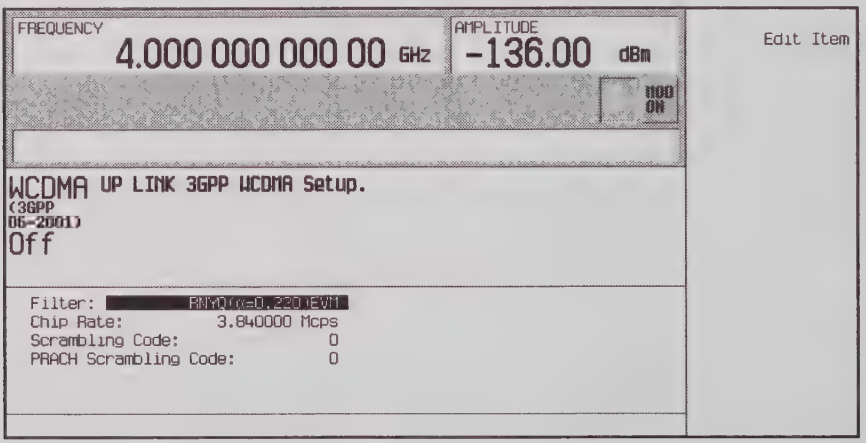
This section teaches you how to build fully coded W-CDMA uplink modulation for testing base station receiver designs. The modulation is generated by the signal generator's internal baseband generator. The procedures in this section build on each other and are designed to be used sequentially.

Configuring the User Equipment Setup

1. Press **Preset**.
2. Press **Mode** > **W-CDMA** > **Real Time W-CDMA** > **Link Down Up** to Up.
3. Press **UE Setup**.

   This opens a menu where you can adjust the filtering type, chip rate, scrambling code, and PRACH scrambling code for the simulated user equipment (see Figure 5-7). Use the arrow keys or the knob to highlight the data fields for editing. Press **Edit Item** to change the value for the desired user equipment parameter.

Figure 5-7 User Equipment Setup



Configuring PRACH

The tasks in this procedure build upon the previous procedure.

The ESG can generate W-CDMA uplink modulation using the physical random access channel (PRACH) or the dedicated physical control channel (DPCCH). This procedure teaches you how to perform a PRACH setup with the following tasks:

- "Modifying the Physical Layer" on page 137
- "Modifying the Transport Layer" on page 137

Modifying the Physical Layer

This task includes an example of setting up a power ramp. For reliable results, you may also need to perform a power search. Refer to "Special Power Control Considerations When Using DPCCH/DPDCH in Compressed Mode or PRACH" on page 314 before completing the following steps:

1. Press **Mode Setup** to return to the top-level real-time W-CDMA menu.
2. Press **Link Control** > **PhyCH Type** > **PRACH**.
3. Press **PhyCH Setup** > **PRACH Setup Code Pwr Time** to Pwr.
4. Move the cursor to highlight the `Max Pwr` field.
5. Press **-50** > **dBm**.
6. Move the cursor to highlight the `Ramp Step` field.
7. Press **1** > **dB**.
8. Move the cursor to highlight the `Num of Pre` field.
9. Press **4** > **Enter**.
10. Press **PRACH Setup Code Pwr Time** to `Time`.
11. Move the cursor to highlight the `Tp-p` field.
12. Press **4** > **Enter**.

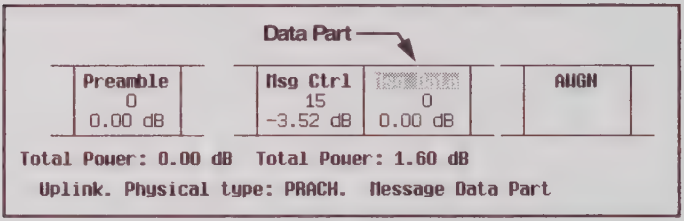
You have now modified the PRACH physical channel parameters to send 4 preambles with a 1 dB power increase for each preamble, and 4 access slots of timing from the beginning of one preamble to the beginning of the next preamble.

Modifying the Transport Layer

The transport channel is available when the PRACH physical channel data type is set to TrCh. This task teaches you how to make changes to the transport layer parameters.

1. Press **Return**.
2. Move the cursor to highlight the `Msg Data` part of the PRACH channel diagram in the center of the display (see Figure 5-8).

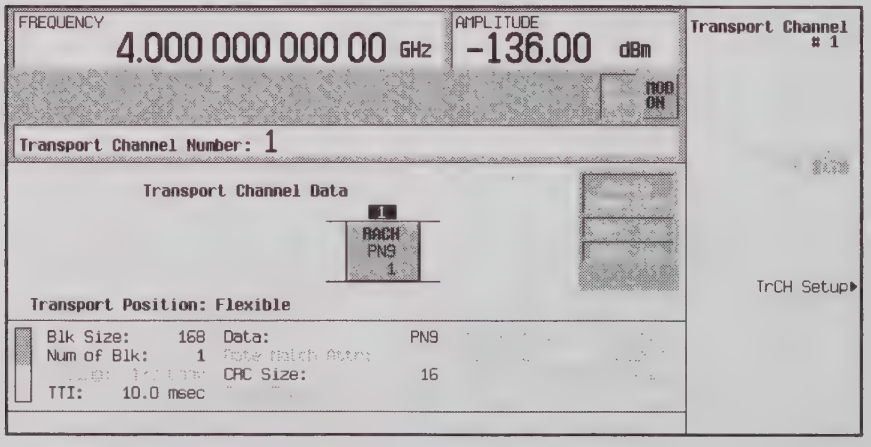
Figure 5-8 PRACH Data Part



3. Press **Transport Setup** > **TrCH Setup**.
4. Move the cursor to highlight the `Blk Size` field.
5. Press **168** > **Enter**. (Ignore this step, if value is already 168)
6. Move the cursor to highlight the `TTI` field.
7. Press **10** > **msec**.

You have now set a block size of 168 with a transmission time interval of 10 ms. Figure 5-9 shows what the display should look like when this task is completed.

Figure 5-9 Transport Layer Setup



Configuring DPCCH/DPDCH

The tasks in this procedure build upon the previous procedure.

The ESG can generate W-CDMA uplink modulation using the physical random access channel (PRACH) or the dedicated physical control channel (DPCCH). This procedure teaches you how to perform a DPCCH setup with the following tasks:

- "Selecting a Reference Measurement Channel" on page 139
- "Modifying the Physical Layer" on page 140
- "Modifying the Transport Layer" on page 141
- "Setting Up the Compressed Mode" on page 142

Selecting a Reference Measurement Channel

The ESG provides a single-softkey solution for configuring the transport layer coding according to the 3GPP W-CDMA specifications for the reference measurement channels (RMC).

1. Press **Mode Setup** to return to the top-level real-time W-CDMA menu.
2. Press **Link Control**.
3. Press **PhyCH Type** > **DPCCH**.
4. Press **2** > **Enter** to highlight channel 2 (DPDCH).
5. Press **Ref Measure Setup** > **RMC 384 kbps (25.141 V3.4)**.

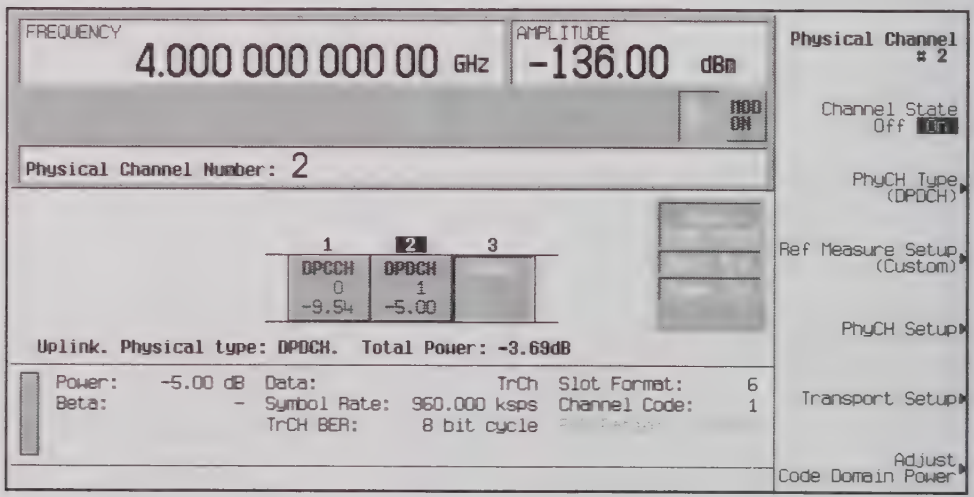
You have now selected a predefined 384 kbps reference measurement channel setup that conforms to the 3GPP 25.141 v3.4 standard. For more information on reference measurement channels, see "Reference Measurement Channels" on page 288.

Modifying the Physical Layer

1. Press **PhyCH Setup**.
2. Move the cursor to highlight the `Power` field.
3. Press **-5 > dB**.
4. Move the cursor to highlight the `TrCH BER` field.
5. Press **8 > Enter**.
6. Press **Return**.

You have now modified the DPDCH channel parameters to have a -5 dB power level and a transport channel bit error rate of 12.5 percent. Figure 5-10 shows what the display should look like when this task is completed.

Figure 5-10 Physical Layer Setup



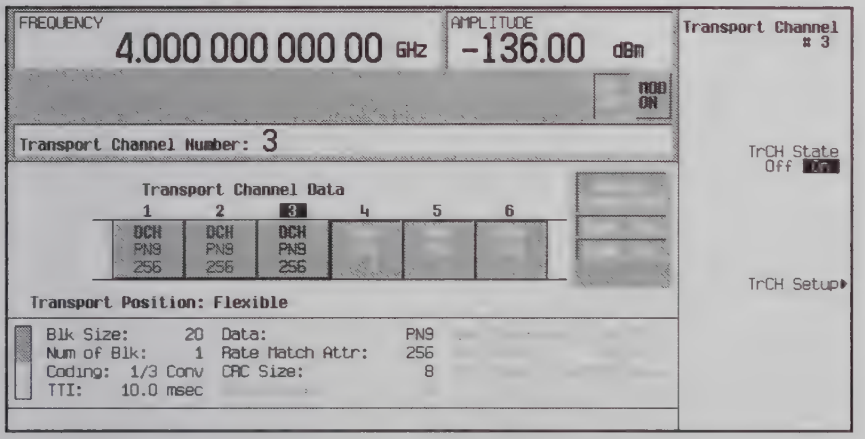
Modifying the Transport Layer

Up to six transport data channels are available to the DPDCH when the DPDCH data type is set to TrCh. This task teaches you how to make changes to the transport layer parameters:

1. Press **Transport Setup**.
2. Press **3** > **Enter** to highlight channel 3.
3. Press **TrCH State Off On** to On.
4. Press **TrCH Setup**.
5. Move the cursor to highlight the `Coding` field.
6. Press **Edit Item** > **1/3 Conv**.
7. Move the cursor to highlight the `Rate Match Attr` field.
8. Press **256** > **Enter**.
9. Press **Return**.

You have now turned on a third transport channel and configured it to use 1/3 convolutional encoding with a rate match attribute of 256. Figure 5-11 shows what the display should look like when this task is completed.

Figure 5-11 Transport Layer Setup



Setting Up the Compressed Mode

The following task will teach you how to set up the compressed frame mode. Table 5-1 defines the parameters that are available for the compressed mode.

Table 5-1 Uplink Compressed Mode Parameters

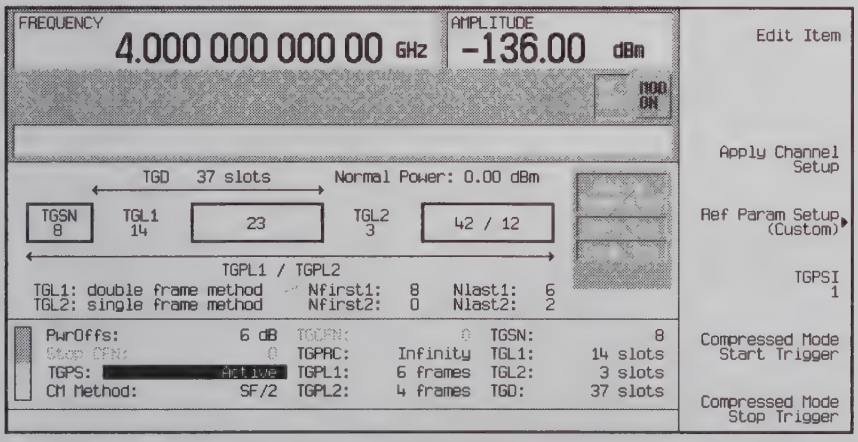
Name	Definition
TGPRC	Transmission Gap Pattern Repetition Count. Number of transmission gap patterns within the transmission gap pattern sequence.
TGCFN	Transmission Gap Connection Frame Number. CFN of the first radio frame of the first pattern within the transmission gap pattern sequence.
TGSN	Transmission Gap Slot Number. Slot number of the first transmission gap slot within the first radio frame of the transmission gap pattern.
TGL1	Transmission Gap Length 1. Duration of the first transmission gap within the transmission gap pattern.
TGL2	Transmission Gap Length 2. Duration of the second transmission gap within the transmission gap pattern.
TGD	Transmission Gap Duration. Duration of the starting slots of two consecutive transmission gaps within a transmission gap pattern.
TGPL1	Transmission Gap Pattern Length 1. Duration of first transmission gap pattern.
TGPL2	Transmission Gap Pattern Length 2. Duration of second transmission gap pattern.
TGPS	Transmission Gap Pattern Support. Enables/disables compressed frame support.
Stop CFN	Stop Connection Frame Number. CFN of the last radio frame.
TGPSI	Transmission Gap Pattern Sequence Identifier. Establishes a reference to the compressed mode pattern sequence. (Only one TGPSI is supported at this time.)

1. Press **Return** > **PhyCH Setup** > **Compressed Mode Setup**.
2. Move the cursor to highlight the `PwrOffs` field.
3. Press **6** > **dB**.
4. Move the cursor to highlight the `TGSN` field.
5. Press **8** > **Enter**.

6. Move the cursor to highlight the TGPL1 field.
7. Press **6** > **Enter**.
8. Move the cursor to highlight the TGPL2 field.
9. Press **4** > **Enter**.
10. Move the cursor to highlight the TGL1 field.
11. Press **14** > **Enter**.
12. Move the cursor to highlight the TGL2 field.
13. Press **3** > **Enter**.
14. Move the cursor to highlight the TGD field.
15. Press **37** > **Enter**.
16. Move the cursor to highlight the TGPS field.
17. Press **Edit Item** > **Active**.

The ESG is now enabled to send compressed frames; however, the ESG will continue to send normal frames until an external trigger is received or the **Compressed Mode Start Trigger** softkey is pressed. Likewise, the **Compressed Mode Stop Trigger** softkey stops the compressed frames from being sent. Figure 5-12 shows what the display should look like when this task is completed. Notice that the first gap (TGL1) uses the double frame method and the second gap (TLG2) uses the single frame method.

Figure 5-12 Compressed Mode Setup



Adjusting Code Domain Power

The tasks in this procedure build upon the previous procedure. This procedure teaches you how to perform the following tasks:

- "Scaling to 0 dB" on page 144
- "Setting Equal Channel Powers" on page 145

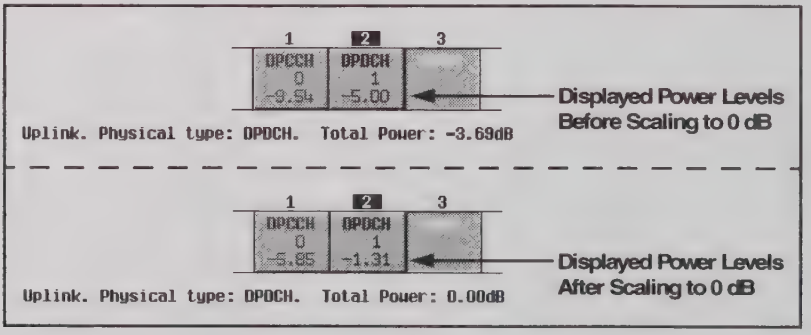
Scaling to 0 dB

After changing the relative power level for a channel, the ESG automatically scales the total power to 0 dB, while preserving the relative channel power levels. Although the displayed total power changes in value as channel powers are adjusted, the actual total power is maintained at 0 dB. The displayed channel power levels remain unchanged, reflecting only user-assigned values, so the user can complete the relative power adjustments. This task teaches you how to update the display to show the normalized relative channel power for each channel after completing the setup.

1. Press **Mode Setup** to return to the top-level real-time W-CDMA menu.
2. Press **Link Control** > **Adjust Code Domain Power** > **Scale to 0 dB**.

The power level displayed for each channel is now changed to show the normalized relative channel power. The values shown in Figure 5-13 result from modifying the DPDCH channel, as described earlier in this section. Notice the displayed power levels before and after the **Scale to 0 dB** softkey is pressed.

Figure 5-13 Scaling to Zero dB (Uplink DPCCH/DPDCH)



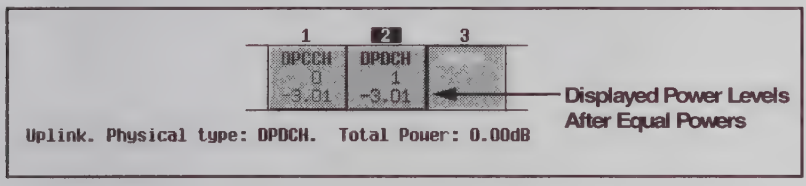
Setting Equal Channel Powers

This task teaches you how to set the relative power level for all active channels to be equal, for a total power level of 0 dB. The normalized relative power level of each channel depends on the number of active channels. This task is an alternative to scaling to 0 dB.

Press **Adjust Code Domain Power** > **Equal Powers**.

All active channels have now been set to equal powers. Figure 5-14 shows the displayed normalized relative power levels after the **Equal Powers** softkey is pressed with two active channels. Depending on the entered channel powers, the displayed total power may show a low residual value (such as `0.02 dB`) due to decimal rounding.

Figure 5-14 Equal Powers (Uplink DPCCH/DPDCH)



Managing Noise

The tasks in this procedure build upon the previous procedure.

The following tasks teach you how to set the overall carrier-to-noise (C/N) ratio for the uplink W-CDMA setup and to set the EbNo value for individual physical channels.

- "Setting the Carrier to Noise Ratio" on page 145
- "Setting EbNo" on page 146

Setting the Carrier to Noise Ratio

1. Press Mode Setup to return to the top-level real-time W-CDMA menu.
2. Press **Link Control** > **3** > **Enter** > **Channel State Off On** to On.
3. Press **PhyCH Setup**.
4. Move the cursor to highlight the `C/N value` field.
5. Press **10** > **dB**.

NOTE Noise values less than 10 dB may not be visible on a spectrum analyzer.

You have now set the overall carrier to noise ratio to 10 dB and turned on noise. This is done to apply a discernible level of noise across the entire channel space.

Setting EbNo

1. Move the cursor to highlight the `Eb Ref` field.
2. Press **Edit Item** > **DPDCH**.
3. Move the cursor to highlight the `Eb/No value` field.
4. Press **15** > **dB**.

NOTE Noise values less than 10 dB may not be visible on a spectrum analyzer.

You have now set the EbNo value for the DPDCH channel to 15 dB. Note that modifying the EbNo value for a channel will change the overall carrier to noise ratio and the EbNo value for all other active channels. For reliable results when making hand calculations to determine or verify EbNo values, it is recommended that you first scale the code domain power to 0 dB to display the normalized relative channel power levels (see "Scaling to 0 dB" on page 144).

Generating the Baseband Signal

The steps in this procedure build upon the previous procedure.

1. Press **Mode Setup** to return to the top-level real-time W-CDMA menu.
2. Press **W-CDMA Off On** to On.

This generates the real-time uplink W-CDMA signal. The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `WCDMA On` and the `WCDMA` and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

Applying New Settings

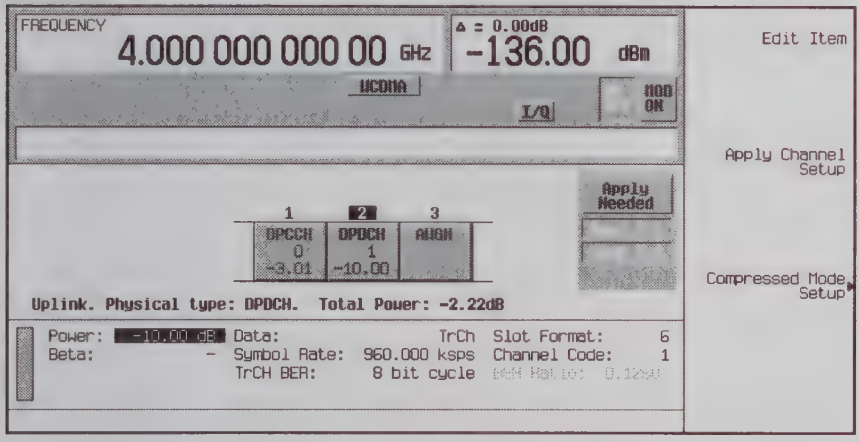
The steps in this procedure build upon the previous procedure.

1. Press **Link Control** > **2** > **Enter**.
2. Press **PhyCH Setup**.
3. Move the cursor to highlight the `Power` field.

4. Press **–10 > dB**.

   Notice that with the personality already turned on, as soon as a channel parameter is changed, the `Apply Needed` annunciator appears (see Figure 5-15). This indicates that the new settings have not yet taken effect in the active baseband signal.

Figure 5-15 Display Indicates that Apply is Needed



5. Press **Apply Channel Setup**.

The new setting to the DPDCH channel is now applied to the baseband signal. Notice also that the `Apply Needed` annunciator is replaced with `Apply Completed`.

Configuring the RF Output

The steps in this procedure build upon the previous procedure.

1. Press **Frequency > 1.92 > GHz**.
2. Press **Amplitude > –10 > dBm**.
3. Press **RF On/Off** to On.

The user-defined, real-time uplink W-CDMA signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register,

see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

cdma2000 Forward Link Modulation

This section teaches you how to build cdma2000 forward link signals for testing mobile receiver designs. The signals are generated by the internal real-time IQ baseband generator. The procedures in this section build on each other and are designed to be used sequentially.

Editing the Base Station Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Real Time CDMA2000**.

NOTE The forward link is the signal generator's default setting for link direction and, therefore, does not need to be set.

3. Press **BaseStation Setup**.
4. Move the cursor to highlight the `filter` field.
5. Press **Edit Item** > **Select** > IS-95 and IS-2000 > **IS-95**.
6. Press **Return** > **Return**.
7. Press **BaseStation Setup**.
8. Move the cursor to highlight the `PN Offset` field.
9. Press **9** > **Enter**.

The cdma2000 forward link global parameters have now been modified so that you are using an IS-95 filter and a PN offset of 9.

Editing Channel Setups

The tasks in this procedure build upon the previous procedure. This procedure teaches you how to perform the following tasks:

- "Changing Channel States" on page 149
- "Modifying Channel Parameters" on page 150

Changing Channel States

This task teaches you how to quickly configure the operating states of the forward link

channels.

1. Press **Mode Setup** to return to the top-level real-time cdma2000 menu.
2. Press **Link Control** > **Channel State Quick Presets** > **All (Except FQPCH)**.

You have now turned on all forward link channels, except for the forward link quick paging channel (F-QPCH). The Channel State Quick Presets menu enables you to configure the operating states of all channels with a single keypress. You can also change the operating state of the selected channel using the **Channel State Off On** softkey, or by editing the `State` field among the Channel Setup parameters.

Modifying Channel Parameters

This task teaches you how to edit the parameters for the selected channel.

1. Move the cursor to highlight the forward fundamental channel (F-FCH).
2. Press **Channel Setup**.
3. Move the cursor to highlight the `Radio Config` field.
4. Press **4** > **Enter**.

NOTE An important change from earlier ESG models is that radio configuration is now independent between fundamental and supplemental channels.

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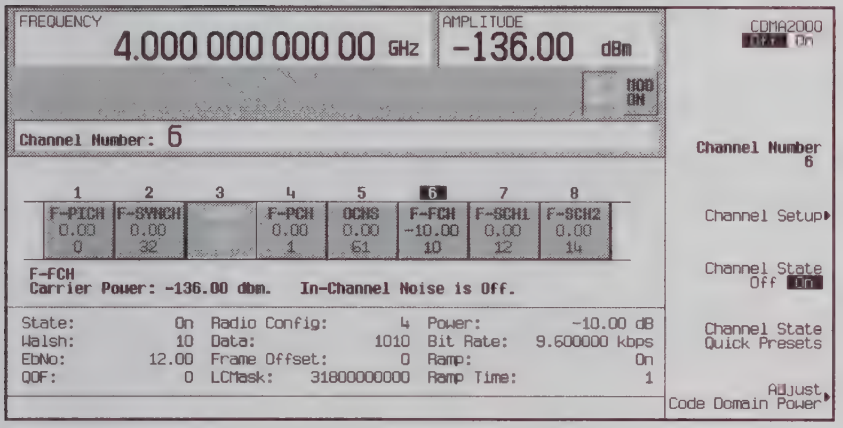
5. Move the cursor to highlight the `Data` field.
6. Press **Edit Item** > **FIX4** > **1010** > **Enter** > **Return**.
7. Move the cursor to highlight the `Power` field.
8. Press **–10** > **dB**.
9. Move the cursor to highlight the `EbNo` field.
10. Press **12** > **dB** > **Return**.

You have now modified the forward fundamental channel parameters so that the radio configuration is 4, the data is a fixed 4-bit pattern of 1010, the relative channel power is –10 dB, and EbNo value is 12 dB. Figure 5-16 on page 151 shows what the display should look like when this task is completed.

Figure 5-16 Forward Fundamental Channel (F-FCH) Setup



Note that the ESG allows you to set the relative channel power for each active channel. To display the normalized relative channel power after completing the setup, it is recommended that you perform the steps in "Adjusting Code Domain Power" on page 151. Also note that varying the EbNo value on one channel will affect the EbNo values on all active channels. Refer to "Managing Noise" on page 152 to learn how to make final noise adjustments.

Adjusting Code Domain Power

The tasks in this procedure build upon the previous procedure. This procedure teaches you how to perform the following tasks:

- "Scaling to 0 dB" on page 151
- "Setting Equal Channel Powers" on page 152

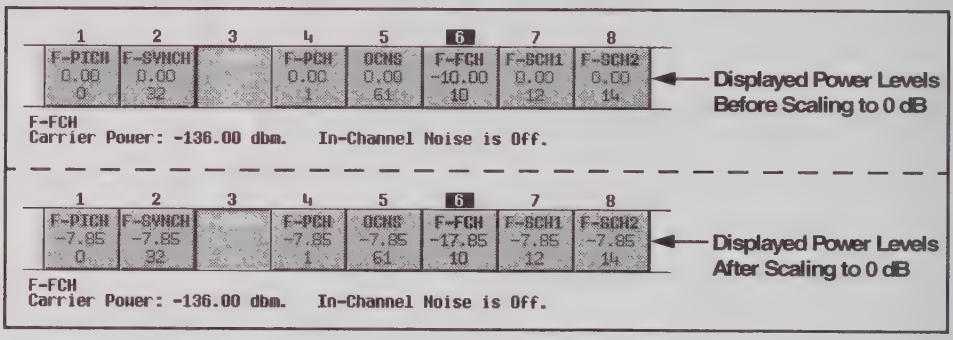
Scaling to 0 dB

After changing the relative power level for a channel, the ESG automatically scales the total power to 0 dB, while preserving the relative channel power levels. The displayed power levels remain unchanged so the user can complete the relative power adjustments. This task teaches you how to update the display to show the normalized relative channel power for each channel after completing the setup.

1. Press **Mode Setup** to return to the top-level real-time cdma2000 menu.
2. Press **Link Control** > **Adjust Code Domain Power** > **Scale to 0 dB**.

The power level displayed for each channel is now changed to show the normalized relative channel power. Figure 5-17 shows the displayed power levels before and after the **Scale to 0 dB** softkey is pressed.

Figure 5-17


1 2 3 4 5 6 7 8
F-PICH 0.00 0
F-SYNCH 0.00 32
F-PCH 0.00 1
OCNS 0.00 61
F-FCH -10.00 10
F-SCH1 0.00 12
F-SCH2 0.00 14
F-FCH
Carrier Power: -136.00 dbm. In-Channel Noise is Off.
Displayed Power Levels Before Scaling to 0 dB
1 2 3 4 5 6 7 8
F-PICH -7.85 0
F-SYNCH -7.85 32
F-PCH -7.85 1
OCNS -7.85 61
F-FCH -17.85 10
F-SCH1 -7.85 12
F-SCH2 -7.85 14
F-FCH
Carrier Power: -136.00 dbm. In-Channel Noise is Off.
Displayed Power Levels After Scaling to 0 dB

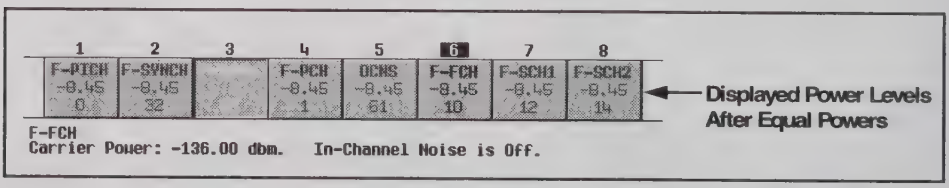
Setting Equal Channel Powers

This task teaches you how to set the relative power level for all active channels to be equal, for a total power level of 0 dB. The normalized relative power level of each channel depends on the number of active channels. This task is an alternative to scaling to 0 dB.

Press **Adjust Code Domain Power** > **Equal Powers**.

All active channels have now been set to equal powers. Figure 5-18 shows the displayed normalized relative power levels after the **Equal Powers** softkey is pressed with seven active channels.

Figure 5-18


1 2 3 4 5 6 7 8
F-PICH -8.45 0
F-SYNCH -8.45 32
F-PCH -8.45 1
OCNS -8.45 61
F-FCH -8.45 10
F-SCH1 -8.45 12
F-SCH2 -8.45 14
F-FCH
Carrier Power: -136.00 dbm. In-Channel Noise is Off.
Displayed Power Levels After Equal Powers

Managing Noise

The tasks in this procedure build upon the previous procedure.

The following tasks teach you how to set the overall carrier-to-noise (C/N) ratio for the

forward link cdma2000 setup and to set the EbNo value for individual physical channels.

- "Setting the Carrier to Noise Ratio" on page 153
- "Setting EbNo" on page 153

Setting the Carrier to Noise Ratio

1. Press **Mode Setup** to return to the top-level real-time cdma2000 menu.
2. Press **Noise Setup** > **C/N** > **10** > **dB**.
3. Press **Noise Off On** to On.

You have now set the overall carrier to noise ratio to 10 dB and turned on noise. This is done to apply a discernible level of noise across the entire channel space.

Setting EbNo

EbNo can be set in the Noise Setup menu or the Channel Setup table editor (see "Modifying Channel Parameters" on page 150). This task teaches you how to make quick EbNo adjustments using the **EbNo** softkey in the Noise Setup menu.

1. Press **Channel Number** and move the cursor to highlight the forward fundamental channel (F-FCH).
2. Press **EbNo** > **20** > **dB**.

You have now set the EbNo value for the F-FCH channel to 20 dB. Note that modifying the EbNo value for a channel will change the overall carrier to noise ratio and the EbNo value for all other active channels. For reliable results when making hand calculations to determine or verify EbNo values, it is recommended that you first scale the code domain power to 0 dB to display the normalized relative channel power levels (see "Scaling to 0 dB" on page 151).

Generating the Baseband Signal

This procedure builds upon the previous procedure.

Press **CDMA2000 Off On** to On.

This generates the real-time forward link cdma2000 signal. The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `CDMA2000 On` and the `CDMA2K` and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

The steps in this procedure build upon the previous procedure.

1. Press **Frequency** > **2.14** > **GHz**.
2. Press **Amplitude** > **–30** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined, real-time forward link cdma2000 signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

cdma2000 Reverse Link Modulation

This section teaches you how to build cdma2000 reverse link signals for testing base station receiver designs. The signals are generated by the internal real-time IQ baseband generator. The procedures in this section build on each other and are designed to be used sequentially.

Editing the Mobile Setup

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Real Time CDMA2000** > **Link Forward Reverse** to Reverse.
3. Press **Mobile Setup**.
4. Move the cursor to highlight the `filter` field.
5. Press **Edit Item** > **Select** > **IS-95 and IS-2000** > **IS-95 Mod**.
6. Press **Return** > **Return**.
7. Press **Mobile Setup**.
8. Move the cursor to highlight the `Long Code Mask` field.
9. Press **3FFF0000000** > **Enter**.

The cdma2000 reverse link global parameters have now been changed so that you are using a modified IS-95 filter and a long code mask of 3FFF0000000.

Editing Channel Setups

The tasks in this procedure build upon the previous procedure. This procedure teaches you how to perform the following tasks:

- "Changing the Operating Mode" on page 155
- "Changing Channel States" on page 156
- "Modifying Channel Parameters" on page 156

Changing the Operating Mode

This task teaches you how to select a predefined reverse link channel configuration.

1. Press **Mode Setup** to return to the top-level real-time cdma2000 menu.
2. Press **Link Control** > **Operating Mode** > **RadioConfig 1/2 Access**.

Notice that the display shows a single reverse access channel. This is an IS-2000 standard channel configuration. For learning purposes, we will change back to RadioConfig 3/4 Traffic, which is the default operating mode.

3. Press **Operating Mode** > **RadioConfig 3/4 Traffic**.

You have now selected RadioConfig 3/4 Traffic as the current operating mode.

Changing Channel States

This task teaches you how to quickly configure the operating states of the reverse link channels.

Press **Channel State Quick Presets** > **All**.

You have now turned on all reverse link channels. The Channel State Quick Presets menu enables you to configure the operating states of all channels with a single keypress. This menu is only available for the reverse link when the RadioConfig 3/4 Traffic operating mode is selected. You can also change the operating state of the selected channel using the **Channel State Off On** softkey, or by editing the `State` field among the Channel Setup parameters.

Modifying Channel Parameters

This task teaches you how to edit the parameters for the selected channel.

1. Move the cursor to highlight the reverse fundamental channel (R-FCH).
2. Press **Channel Setup**.
3. Move the cursor to highlight the `Radio Config` field.
4. Press **4** > **Enter**.

NOTE An important change from earlier ESG models is that radio configuration is now independent between fundamental and supplemental channels.

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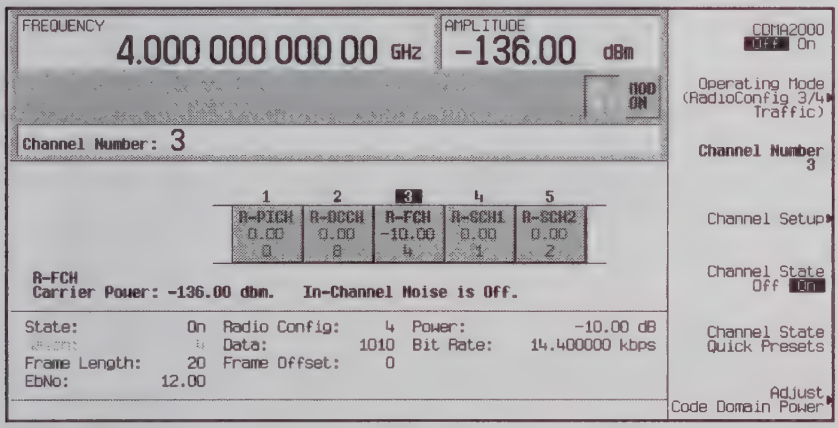
5. Move the cursor to highlight the `Data` field.
6. Press **Edit Item** > **FIX4** > **1010** >**Enter** > **Return**.
7. Move the cursor to highlight the `Power` field.
8. Press **–10** > **dB**.
9. Move the cursor to highlight the `EbNo` field.

10. Press **12 > dB > Return**.

You have now modified the reverse fundamental channel parameters so that the radio configuration is 4, the data is a fixed 4-bit pattern of 1010, the relative channel power is -10 dB, and EbNo value is 12 dB. Figure 5-19 shows what the display should look like when this task is completed.

Figure 5-19 Reverse Fundamental Channel (R-FCH) Setup



Note that the ESG allows you to set the relative channel power for each active channel. To display the normalized relative channel power after completing the setup, it is recommended that you perform the steps in "Adjusting Code Domain Power" on page 157. Also note that varying the EbNo value on one channel will affect the EbNo values on all active channels. Refer to "Managing Noise" on page 159 to learn how to make final noise adjustments.

Adjusting Code Domain Power

The tasks in this procedure build upon the previous procedure. This procedure teaches you how to perform the following tasks:

- "Scaling to 0 dB" on page 157
- "Setting Equal Channel Powers" on page 158

Scaling to 0 dB

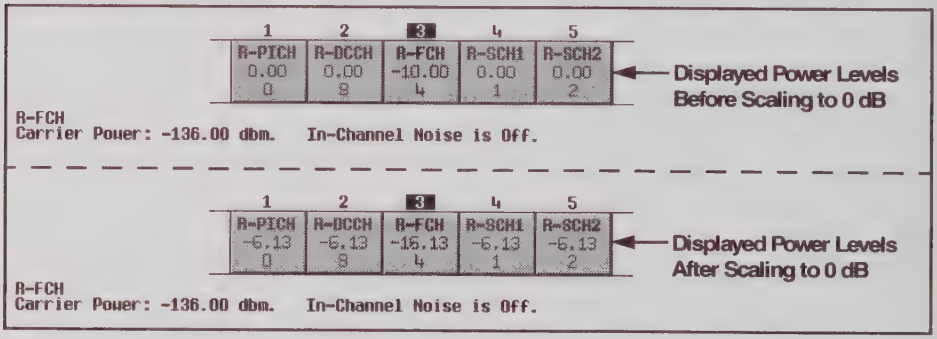
After changing the relative power level for a channel, the ESG automatically scales the total power to 0 dB, while preserving the relative channel power levels. The displayed power levels

remain unchanged so the user can complete the relative power adjustments. This task teaches you how to update the display to show the normalized relative channel power for each channel after completing the setup.

1. Press **Mode Setup** to return to the top-level real-time cdma2000 menu.
2. Press **Link Control** > **Adjust Code Domain Power** > **Scale to 0 dB**.

The power level displayed for each channel is now changed to show the normalized relative channel power. Figure 5-20 shows the displayed power levels before and after the **Scale to 0 dB** softkey is pressed.

Figure 5-20


1 2 3 4 5
R-PICH R-DCCH R-FCH R-SCH1 R-SCH2
0.00 0.00 -10.00 0.00 0.00
0 8 4 1 2
Displayed Power Levels Before Scaling to 0 dB
R-FCH
Carrier Power: -136.00 dbm. In-Channel Noise is Off.
1 2 3 4 5
R-PICH R-DCCH R-FCH R-SCH1 R-SCH2
-6.13 -6.13 -16.13 -6.13 -6.13
0 8 4 1 2
Displayed Power Levels After Scaling to 0 dB
R-FCH
Carrier Power: -136.00 dbm. In-Channel Noise is Off.

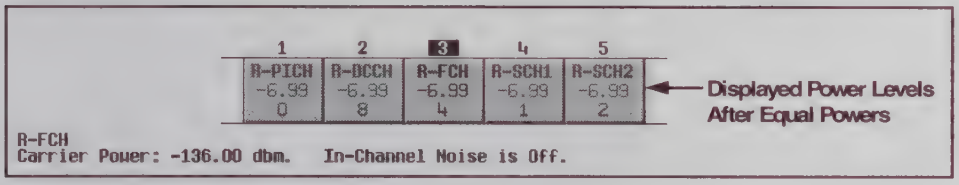
Setting Equal Channel Powers

This task teaches you how to set the relative power level for all active channels to be equal, for a total power level of 0 dB. The normalized relative power level of each channel depends on the number of active channels. This task is an alternative to scaling to 0 dB.

Press **Adjust Code Domain Power** > **Equal Powers**.

All active channels have now been set to equal powers. Figure 5-21 shows the displayed normalized relative power levels after the **Equal Powers** softkey is pressed with five active channels.

Figure 5-21



Managing Noise

The tasks in this procedure build upon the previous procedure.

The following tasks teach you how to set the overall carrier-to-noise (C/N) ratio for the reverse link cdma2000 setup and to set the EbNo value for individual physical channels.

- "Setting the Carrier to Noise Ratio" on page 159
- "Setting EbNo" on page 159

Setting the Carrier to Noise Ratio

1. Press **Mode Setup** to return to the top-level real-time cdma2000 menu.
2. Press **Noise Setup** > **C/N** > **10** > **dB**.
3. Press **Noise Off On** to On.

You have now set the overall carrier to noise ratio to 10 dB and turned on noise. This is done to apply a discernible level of noise across the entire channel space.

Setting EbNo

EbNo can be set in the Noise Setup menu or the Channel Setup table editor (see "Modifying Channel Parameters" on page 156). This task teaches you how to make quick EbNo adjustments using the **EbNo** softkey in the Noise Setup menu.

1. Press **Channel Number** and move the cursor to highlight the reverse fundamental channel (R-FCH).
2. Press **EbNo** > **20** > **dB**.

You have now set the EbNo value for the R-FCH channel to 20 dB. Note that modifying the EbNo value for a channel will change the overall carrier to noise ratio and the EbNo value for all other active channels. For reliable results when making hand calculations to determine or verify EbNo values, it is recommended that you first scale the code domain power to 0 dB to display the normalized relative channel power levels (see "Scaling to 0 dB" on page 157).

Generating the Baseband Signal

This procedure builds upon the previous procedure.

Press **CDMA2000 Off On** to On.

This generates the real-time reverse link cdma2000 signal. The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `CDMA2000 On` and the `CDMA2K` and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

The steps in this procedure build upon the previous procedure.

1. Press **Frequency > 2.14 > GHz**.
2. Press **Amplitude > –30 > dBm**.
3. Press **RF On/Off** to On.

The user defined, real-time reverse link cdma2000 signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

Bluetooth Signals

Option 406 is required to perform the following procedure.

This procedure will show you how to set up a sample Bluetooth packet with impairments that include additive white gaussian noise (AWGN) using the front panel keys of the ESG. The procedures in this section build on each other and are designed to be used sequentially.

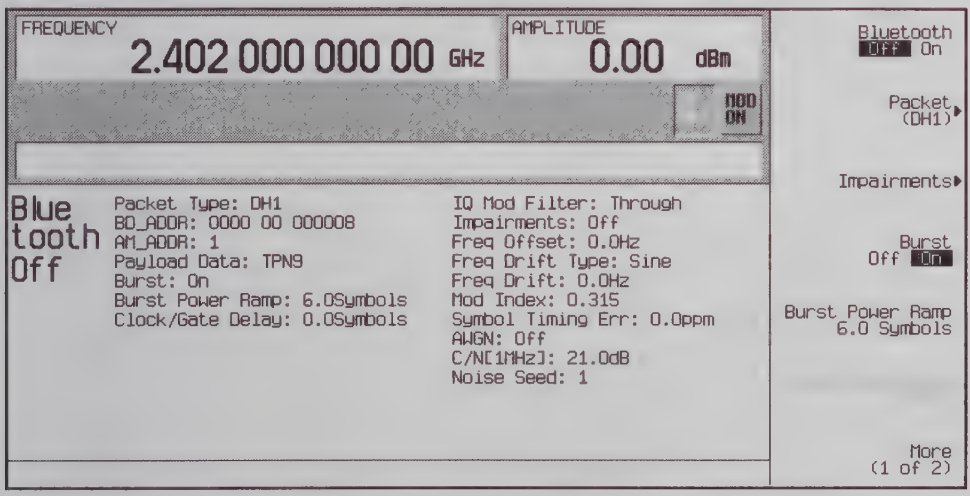
Accessing the Bluetooth Setup Menu on the ESG

1. Press **Preset**, then press **Mode** > **More (1 of 2)** > **Wireless Networking** > **Bluetooth**.

NOTE For this section, the frequency and amplitude are set to typical Bluetooth values.

2. Press **Frequency** > **2.402** > **GHz** > **Amplitude** > **10** > **dBm** > **Mode Setup**.

The following figure shows a display of the Bluetooth menu.



Setting Up Packet Parameters

The steps in this procedure build upon the previous procedure.

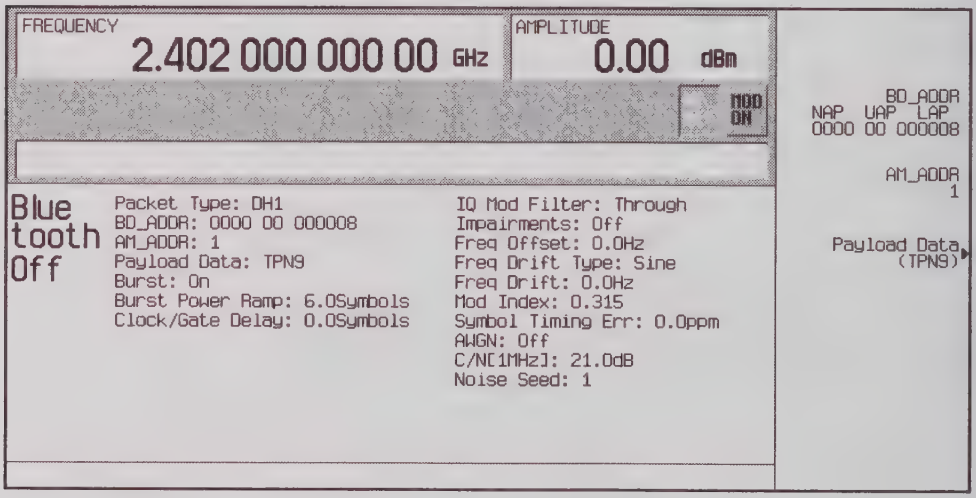
The signal generator uses a DH1 (Data-High rate) packet for the Bluetooth format. The DH1 packet is a single bundle of information transmitted within a piconet and covers a single timeslot. This packet consists of 3 entities: the access code, the header, and the payload.

In the following example you will set the parameters of the DH1 packet.

1. Press **Packet (DH1)**.

   This accesses a menu that enables you to set the packet parameters.

   The following figure displays the packet menu.



2. Press **BD_ADDR > 000000 00 1000 > Enter**.

   This modifies the hexadecimal Bluetooth device address. Each Bluetooth transceiver is allocated a unique 48-bit Bluetooth device address. This address is derived from the IEEE802 standard.

   For addresses with alpha characters, use the softkeys along with the keypad for data entry.

3. Press **AM_ADDR > 4 > Enter**.

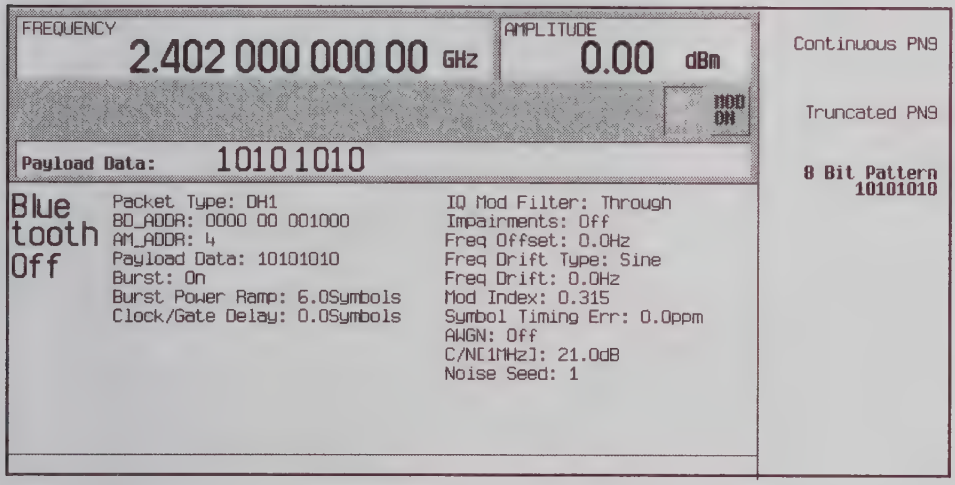
   This sets the active member address and is used to distinguish between the active members participating on the piconet.

NOTE The all-zero AM_ADDR is reserved for broadcast messages.

4. Press **Payload Data** > **8 Bit Pattern** > **10101010** > **Enter**.

   This selects a repeating 8-bit pattern as the payload data.

The following figure now displays the new packet parameters.



Setting up Impairments

The steps in this procedure build upon the previous procedure. This procedure teaches you how to set up the parameters for the impairment function.

1. Press **Return** > **Return** > **Impairments**.

   This accesses a menu which enables you to set up impairments.

2. Press **Freq Offset** > **25** > **kHz**.

3. Press **Freq Drift Type Linear Sine**.

   This sets the frequency drift type to linear. Linear frequency drift will occur across a period of time equal to the duration of one fully loaded DH1 packet, regardless of the packet length. The default setting is the sine drift deviation which is plus or minus from the carrier center frequency.

4. Press **Drift Deviation** > **25** > **kHz**.

   This sets the maximum deviation of the frequency drift of the carrier frequency.

5. Press **Mod Index** > **.325** > **Enter**.

   Modulation index is defined as the ratio of peak-to-peak frequency deviation to the bit rate. When modifying the Mod Index parameter, the peak-to-peak frequency deviation only is changed.

6. Press **Symbol Timing Err** > **1** > **ppm**.

   This sets the symbol timing error in parts per million.

7. Press **AWGN**.

   This accesses a menu from which you can select the parameters of the additive white Gaussian noise (AWGN) to be applied as an impairment to the Bluetooth signal. The following parameters may be changed while AWGN is off, but will not be applied unless **AWGN** and **Impairments** are both turned on.

   a. Press **C/N [1MHz]** > **20** > **dB**.

      This sets the carrier-to-noise ratio for a 1 MHz bandwidth.

   b. Press **Noise Seed** > **2** > **Enter**.

      This sets the noise seed value used to assign a specific sequence of noise to be added to the basic Bluetooth signal. The noise seed is used to initialize the 16-bit shift register used for noise generation. Different noise seeds generate different combinations of noise.

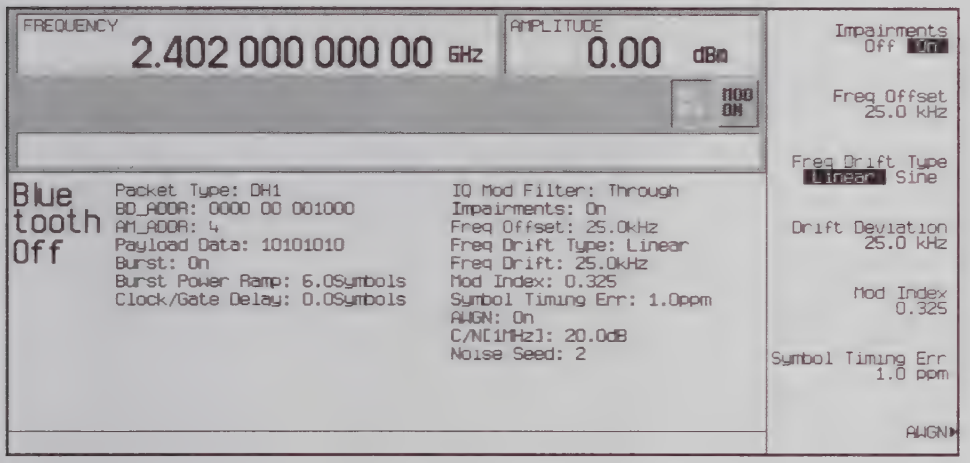
   c. Press **AWGN Off On** to On.

      This turns the AWGN, as a Bluetooth impairment, on.

8. Press **Return** > **Impairments Off On** to On.

   This returns you to the Impairments menu and turns the impairments function on.

The following figure displays the impairment parameters.



Using Burst

The steps in this procedure build upon the previous procedure.

1. Press **Return** to return to the top-level Bluetooth menu.
2. Notice that **Burst Off On** is set to On.

When burst is on, the signal power ramps up prior to transmitting the packet and then ramps down at the end of the packet transmission. When burst is off, the transmitted packets link in a series with no power ramping. The default burst setting is on, but for troubleshooting you may want to turn bursting off.

For this example burst is left in the on position.

Setting the Burst Power Ramp

This procedure builds upon the previous procedure.

Press **Burst Power Ramp > 4 > Symbols**.

This sets the duration of the power ramp to 4 symbols prior to transmitting the first symbol of the packet.

Using Clock/Gate Delay

The steps in this procedure build upon the previous procedure.

This function is available only when the payload data is continuous PN9 and is intended to be used during bit error rate (BER) testing.

1. Press **Packet (DH1)** > **Payload Data** > **Continuous PN9** > **Return**.

   This activates the configuration that generates clock and gate signals relative to the Bluetooth signal.

2. Press **Clock/Gate Delay** > **4** > **Symbols**.

   The clock and gate will be delayed 4 symbols to synchronize with the demodulated data signal from the device under test (DUT) at the input of the BER analyzer.

Turning On a Bluetooth Signal

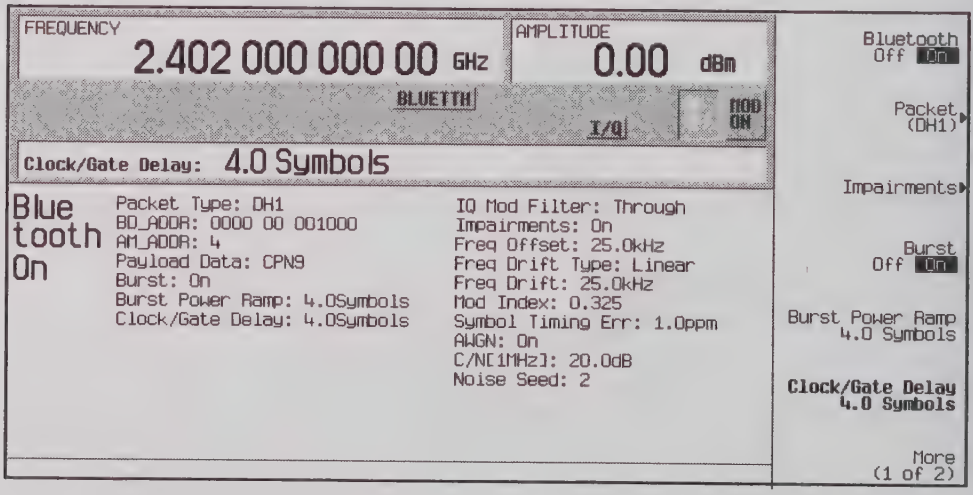
This procedure builds upon the previous procedure.

Press **Bluetooth Off On** to On.

This turns the operating state of the Bluetooth signal generator on.

The front panel I/Q and BLUETTH annunciators appear, and the signal builds.

The following figure displays the Bluetooth signal parameters.



EDGE Framed Modulation

This example teaches you how to build framed real-time I/Q baseband generated EDGE modulation for testing receiver designs. The procedures in this section build on each other and are designed to be used sequentially.

Activating Framed Data Format

1. Press **Preset**.
2. Press **Mode** > **Real Time TDMA** > **EDGE** > **Data Format Pattern Framed**.

Configuring the First Timeslot

1. Press **Configure Timeslots** > **Timeslot Type** > **Custom**.
2. Press **Configure Custom** > **Data** > **FIX4**.
3. Press **1010** > **Enter** > **Return** > **Return**.

Configuring the Second Timeslot

1. Press **Timeslot #** > **1** > **Enter**.
2. Press **Configure Normal** > **TS** > **TSC1** > **Return**.
3. Press **Timeslot Off On** to On > **Return**.

Generating the Baseband Signal

Press **EDGE Off On** to On.

This generates an EDGE signal with an active custom timeslot (#0) and an active normal timeslot (#1). The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `EDGE On` and the `EDGE`, `ENVLP`, and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

1. Press **Frequency** > **891** > **MHz**.
2. Press **Amplitude** > **-5** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined EDGE signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

GSM Framed Modulation

This example teaches you how to build framed real-time I/Q baseband generated GSM modulation for testing receiver designs. The procedures in this section build on each other and are designed to be used sequentially.

Activating Framed Data Format

1. Press **Preset**.
2. Press **Mode** > **Real Time TDMA** > **GSM** > **Data Format Pattern Framed**.

Configuring the First Timeslot

1. Press **Configure Timeslots** > **Timeslot Type** > **Access**.
2. Press **Configure Access** > **E** > **FIX4**.
3. Press **1010** > **Enter** > **Return** > **Return**.

Configuring the Second Timeslot

1. Press **Timeslot #** > **1** > **Enter**.
2. Press **Timeslot Type** > **Custom**.
3. Press **Configure Custom** > **Other Patterns** > **8 1's & 8 0's**.
4. Press **Timeslot Off On** to On > **Return**.

Generating the Baseband Signal

Press **GSM Off On** to On.

This generates a GSM signal with an active access timeslot (#0) and an active custom timeslot (#1). The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `GSM On` and the `GSM`, `ENVLP`, and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

1. Press **Frequency** > **891** > **MHz**.
2. Press **Amplitude** > **-5** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined GSM signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

DECT Framed Modulation

This example teaches you how to build framed real-time I/Q baseband generated DECT modulation for testing receiver designs. The procedures in this section build on each other and are designed to be used sequentially.

Activating Framed Data Format

1. Press **Preset**.
2. Press **Mode** > **Real Time TDMA** > **More (1 of 2)** > **DECT** > **Data Format Pattern Framed**.

Configuring the First Timeslot

1. Press **Configure Timeslots** > **Timeslot Type** > **Custom**.
2. Press **Configure Custom** > **Other Patterns** > **8 1's & 8 0's**.

Configuring the Second Timeslot

1. Press **Timeslot #** > **1** > **Enter**.
2. Press **Timeslot Type** > **Traffic Bearer**.
3. Press **Configure Traffic Bearer** > **B field** > **Other Patterns** > **4 1's & 4 0's**.
4. Press **Return** > **Timeslot Off On** to On > **Return**.

Generating the Baseband Signal. Press **DECT Off On** to On.

This generates a DECT signal with an active custom timeslot (#0) and an active traffic bearer timeslot (#1). The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `DECT On` and the `DECT`, `ENVLP`, and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

1. Press **Frequency** > **1.89** > **GHz**.

2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined DECT signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

PHS Framed Modulation

This example teaches you how to build framed real-time I/Q baseband generated PHS modulation for testing receiver designs. The procedures in this section build on each other and are designed to be used sequentially.

Activating Framed Data Format

1. Press **Preset**.
2. Press **Mode** > **Real Time TDMA** > **PHS** > **Data Format Pattern Framed**.

Configuring the First Timeslot

1. Press **Configure Timeslots** > **Timeslot Type** > **Custom**.
2. Press **Configure Custom** > **FIX4**.
3. Press **1010** > **Enter** > **Return**.

Configuring the Second Timeslot

1. Press **Control Channel Dnlink Uplink**.
2. Press **Timeslot Type** > **Custom**.
3. Press **Configure Custom** > **Other Patterns** > **4 1's & 4 0's**.
4. Press **Return**.

Generating the Baseband Signal

Press **PHS Off On** to On

This generates a PHS signal with an active downlink custom timeslot (#1) and an active uplink custom timeslot (#1). The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `PHS On` and the `PHS`, `ENVLP`, and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

1. Press **Frequency** > **1.89515** > **GHz**.
2. Press **Amplitude** > **0** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined PHS signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

PDC Framed Modulation

This example teaches you how to build framed real-time I/Q baseband generated PDC modulation for testing receiver designs. The procedures in this section build on each other and are designed to be used sequentially.

Activating Framed Data Format

1. Press **Preset**.
2. Press **Mode** > **Real Time TDMA** > **PDC** > **Data Format Pattern Framed**.

Configuring the First Timeslot

1. Press **Configure Timeslots** > **Timeslot Type** > **Down TCH**.
2. Press **Configure Down TCH** > **TCH** > **FIX4**.
3. Press **1010** > **Enter** > **Return** > **Return**.

Configuring the Second Timeslot

1. Press **Rate Full Half**.
2. Press **Timeslot** > **3** > **Enter**.
3. Press **Timeslot Type** > **Down TCH**.
4. Press **Configure Down TCH** > **TCH** > **Other Patterns** > **4 1's & 4 0's**.
5. Press **Return** > **Timeslot Off On** to On > **Return**.

Generating the Baseband Signal

Press **PDC Off On** to On.

This generates a half rate PDC signal with an active downlink traffic channel timeslot (#0) and an active downlink traffic channel timeslot (#3). The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `PDC On` and the `PDC`, `ENVLP`, and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an

instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

1. Press **Frequency** > **832** > **MHz**.
2. Press **Amplitude** > **0** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined PDC signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

NADC Framed Modulation

This example teaches you how to build framed real-time I/Q baseband generated NADC modulation for testing receiver designs. The procedures in this section build on each other and are designed to be used sequentially.

Activating Framed Data Format

1. Press **Preset**.
2. Press **Mode** > **Real Time TDMA** > **NADC** > **Data Format Pattern Framed**.

Configuring the First Timeslot

1. Press **Configure Timeslots** > **Timeslot Type** > **Down TCH**.
2. Press **Configure Down TCH** > **Data** > **FIX4**.
3. Press **1010** > **Enter** > **Return** > **Return**.

Configuring the Second Timeslot

1. Press **Rate Full Half**.
2. Press **Timeslot** > **4** > **Enter**.
3. Press **Timeslot Type** > **Down TCH**.
4. Press **Configure Down TCH** > **Data** > **Other Patterns** > **4 1's & 4 0's**.
5. Press **Return** > **Timeslot Off On** to On > **Return**.

Generating the Baseband Signal

Press **NADC Off On** to On.

This generates a half rate NADC signal with an active downlink traffic channel timeslot (#1) and an active downlink traffic channel timeslot (#4). The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `NADC On` and the `NADC`, `ENVLP`, and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an

instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

1. Press **Frequency** > **835** > **MHz**.
2. Press **Amplitude** > **0** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined NADC signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

TETRA Framed Modulation

This example teaches you how to build framed real-time I/Q baseband generated TETRA modulation for testing receiver designs. The procedures in this section build on each other and are designed to be used sequentially.

Activating Framed Data Format

1. Press **Preset**.
2. Press **Mode** > **Real Time TDMA** > **More (1 of 2)** > **TETRA** > **Data Format Pattern Framed**.

Configuring the First Timeslot

1. Press **Configure Timeslots** > **Timeslot Type** > **Up Control 1**.
2. Press **Configure Up Control 1** > **Data** > **FIX4**.
3. Press **1010** > **Enter** > **Return** > **Return**.

Configuring the Second Timeslot

1. Press **Timeslot** > **2** > **Enter**.
2. Press **Timeslot Type** > **Up Custom**.
3. Press **Configure Up Custom** > **Other Patterns** > **4 1's & 4 0's**.
4. Press **Timeslot Off On** to On > **Return**.

Generating the Baseband Signal

Press **TETRA Off On** to On.

This generates a TETRA signal with an active uplink control 1 timeslot (#1) and an active uplink custom timeslot (#2). The signal generator may require several seconds to build the signal. During this time, `Baseband Reconfiguring` appears on the display. After the reconfiguration is complete, the display reads `TETRA On` and the `TETRA`, `ENVLP`, and `I/Q` annunciators appear. The signal is now modulating the RF carrier.

The signal's configuration data resides in volatile memory and is not recoverable after an instrument preset, power cycle, or reconfigured signal generation.

Configuring the RF Output

1. Press **Frequency** > **1.894880** > **MHz**.
2. Press **Amplitude** > **0** > **dBm**.
3. Press **RF On/Off** to On.

The user-defined TETRA signal is now available at the signal generator's RF OUTPUT connector.

To store this real-time I/Q baseband digital modulation state to the instrument state register, see "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

To recall a real-time I/Q baseband digital modulation state, see "Recalling a Real-Time I/Q Baseband Digital Modulation State" on page 181.

Using the Instrument State Register with Digital Modulation States

The instrument state register is a section of memory divided into 10 sequences (numbered 0 through 9) each containing 100 registers (numbered 00 through 99). It is used to store and recall the RF output amplitude, frequency, and digital modulation settings. It provides a quick alternative to reconfiguring the signal generator via the front panel or SCPI commands when switching between different signal configurations. Once an instrument state has been saved, all of the frequency, amplitude, and modulation settings can be recalled with minimum effort.

Storing a Real-Time I/Q Baseband Digital Modulation State

In this example, you learn how to store an instrument state containing an active real-time digital modulation. If you have not created an active real-time digital modulation state, complete the steps in the previous section, "EDGE Framed Modulation" on page 167.

1. Press the **Save** hardkey.
2. Press **Select Reg:** and turn the knob until `(available)` appears next to a register number.
3. Press **SAVE** softkey.

   The register number appears highlighted in the catalog of `Saved States`.
4. Press **Add Comment To**.
5. Enter a descriptive comment (for example, `EDGE1`) using the alpha keys and the numeric keypad.
6. Press **Enter**.

The real-time I/Q baseband digital modulation state is now stored in the instrument state register.

Recalling a Real-Time I/Q Baseband Digital Modulation State

In this example, you learn how to recall an instrument state containing an active real-time I/Q baseband digital modulation. If you have not created and stored a real-time I/Q baseband digital modulation state, complete the steps in the previous section, "EDGE Framed Modulation" on page 167 and "Storing a Real-Time I/Q Baseband Digital Modulation State" on page 181.

1. Press **Recall** > **RECALL Reg**.

2. Enter the register number (for example, 01) using the numeric keypad.
3. Press **Enter**.

The signal generator is now returned to the real-time I/Q baseband digital modulation state parameters defined in the selected register.

Editing Instrument State Register Comments

The Edit Comment In softkey enables you to edit a comment that is associated with a register in use. Use the front panel arrow keys or the RPG knob to navigate to the register you wish to edit. The register number is listed in the text area of the display and the comment is shown immediately following the register number.

Using the Bit File Editor to Create and Edit User Files

This procedure teaches you how to use the `Bit File Editor` to create, edit, and store user-defined files for data transmission within real-time I/Q baseband generated modulation. For this example, a user file is defined within a custom digital communications format.

User files (user-defined data files) can be created on a remote computer and moved to the signal generator for subsequent modification, or they can be created and modified using the signal generator's `Bit File Editor`.

These user files can then be applied as the transmitted data within a framed TDMA modulation, transmitted as a continuous unframed data stream according to the protocol of the active TDMA format, transmitted as the data for a custom modulation or real-time CDMA format, or for GPS applications. User files are not available for signals generated by the dual arbitrary signal generator.

A real-time digital modulation personality must be selected when ***desired real-time format*** appears in the key press path.

NOTE For information on creating user-defined data files on a remote computer, see the programming guide.

Creating a User File

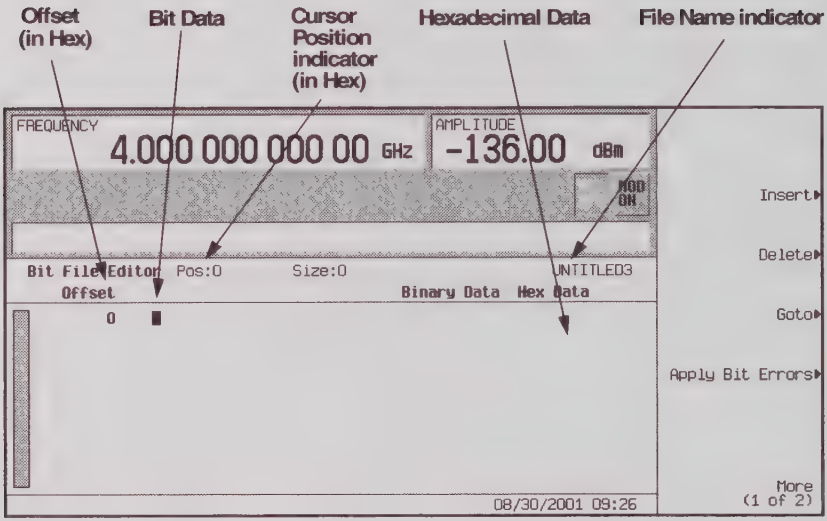
This section teaches you how to perform the following tasks:

- "Accessing the Table Editor" on page 183
- "Entering Bit Values" on page 185

Accessing the Table Editor

1. Press **Preset**.
2. Press **Mode** > ***desired real-time format*** > **Data** > **User File** > **Create File**.

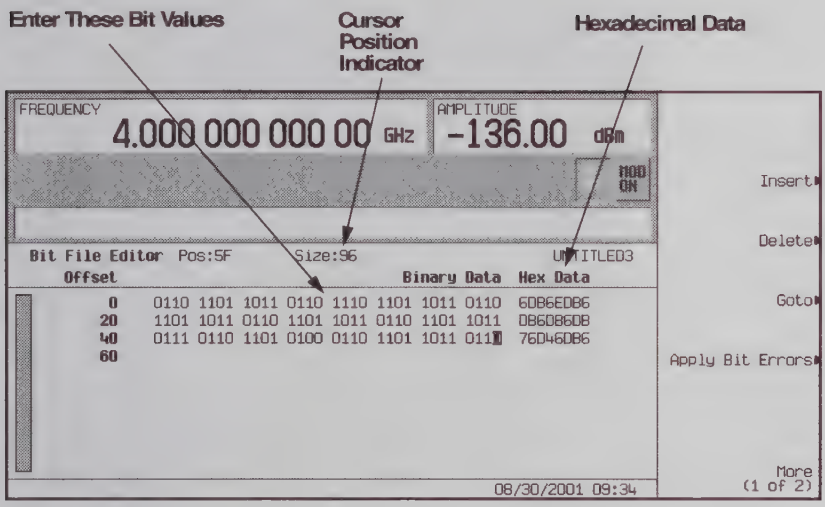
   This opens the `Bit File Editor`. The `Bit File Editor` contains three columns: `Offset`, `Binary Data`, and `Hex Data`, as well as cursor position (`Position`) and file name (`Name`) indicators, as shown in the following figure.



NOTE When you create new file, the default name appears as `UNTITLED`, or `UNTITLED1`, and so forth. This prevents overwriting previous files.

Entering Bit Values

1. Refer to the following figure.



2. Enter the 32 bit values shown.

Bit data is entered into the table editor in 1-bit format. The current hexadecimal value of the binary data is shown in the `Hex Data` column, and the cursor position (in hexadecimal) is shown in the `Position` indicator.

Renaming and Saving a User File

In this example, you learn how to store a user file. If you have not created a user file, complete the steps in the previous section, "Creating a User File" on page 183.

1. Press **More (1 of 2)** > **Rename** > **Editing Keys** > **Clear Text**.
2. Enter a file name (for example, `USER1`) using the alpha keys and the numeric keypad.
3. Press **Enter**.

   The user file has now been renamed and stored to the `Bit` memory catalog with the name `USER1`.

Recalling a User File

In this example, you learn how to recall a user-defined data file from the memory catalog. If you have not created and stored a user-defined data file, complete the steps in the previous sections, "Creating a User File" on page 183 and "Renaming and Saving a User File" on page 185.

1. Press **Preset**.
2. Press **Mode** > ***desired real-time format*** > **Data** > **User File**.
3. Highlight the file `USER1`.
4. Press **Edit File**.

   The `Bit File Editor` opens the file `USER1`.

Modifying an Existing User File

In this example, you learn how to modify an existing user-defined data file. If you have not created, stored, and recalled a user-defined data file, complete the steps in the previous sections, "Creating a User File" on page 183, "Renaming and Saving a User File" on page 185 and "Recalling a User File" on page 186.

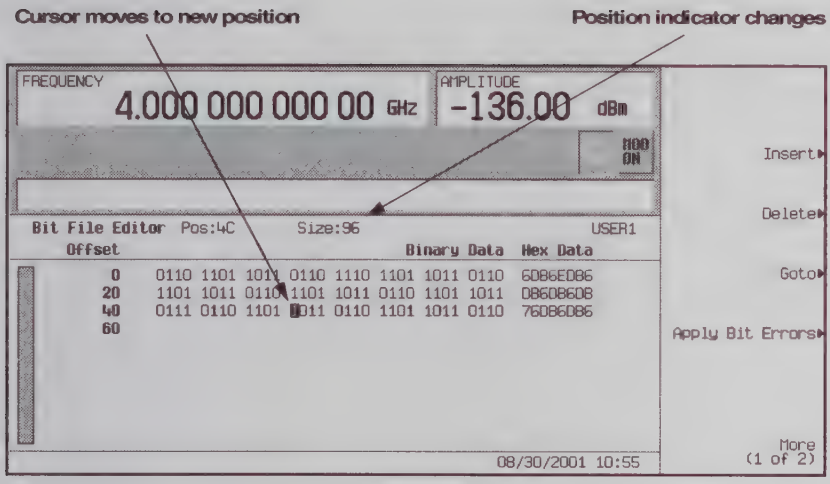
This section teaches you how to perform the following tasks:

- "Navigating the Bit Values" on page 186
- "Inverting Bit Values" on page 187

Navigating the Bit Values

Press **Goto** > **4** > **C** > **Enter**.

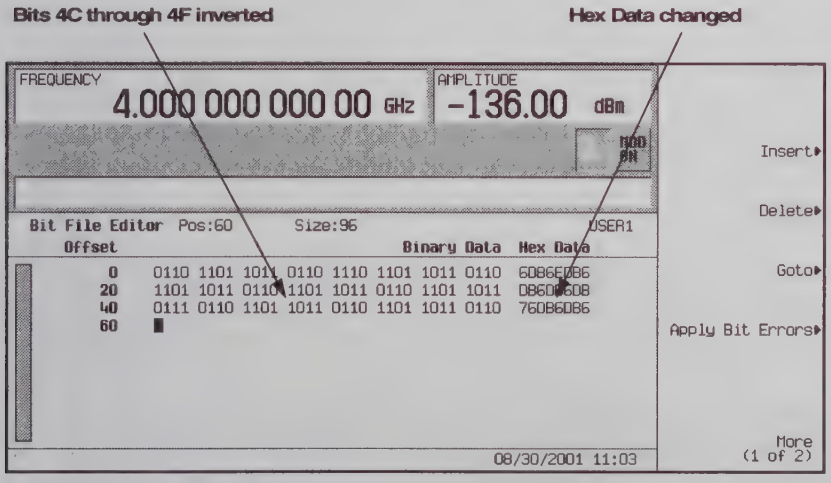
This moves the cursor to bit position 4C in the table, as shown in the following figure.



Inverting Bit Values

1. Press **1011**.

   This inverts the bit values that are positioned 4C through 4F. Notice that hex data in this row has now changed to 76DB6DB6, as shown in the following figure.



Applying Bit Errors to a User File

In this example, you learn how to apply bit errors to a user-defined data file. If you have not created and stored a user-defined data file, complete the steps in the previous sections, "Creating a User File" on page 183 and "Renaming and Saving a User File" on page 185.

1. Press **Apply Bit Errors**.
2. Press **Bit Errors** > **5** > **Enter**.
3. Press **Apply Bit Errors**.

Notice both **Bit Errors** softkeys change value as they are linked.

GPS Operation

This section guides you through the basic operation for using the real-time GPS option.

Setting Up the GPS Signal

If the signal generator is in the factory-defined preset mode, (**Utility** > **Power On/Preset** > **Preset Normal User** to Normal) a basic GPS signal will automatically be set up when the **Preset** key is pressed, then performing step 2 and steps 6 through 8 will generate a signal at the RF OUTPUT connector. To set up a signal using additional features of the GPS personality, complete this procedure starting with step 1.

1. Press **Preset**.
2. Press **Mode** > **More (1 of 2)** > **Real Time GPS**.
3. Press **Satellite ID** > **8** > **Enter**.
4. Press **Doppler Shift** > **2.5** > **kHz.**
5. Press **Data Mode Enc TLM** to Enc.
6. Press **Data** > **PN Sequence** > **PN15**.

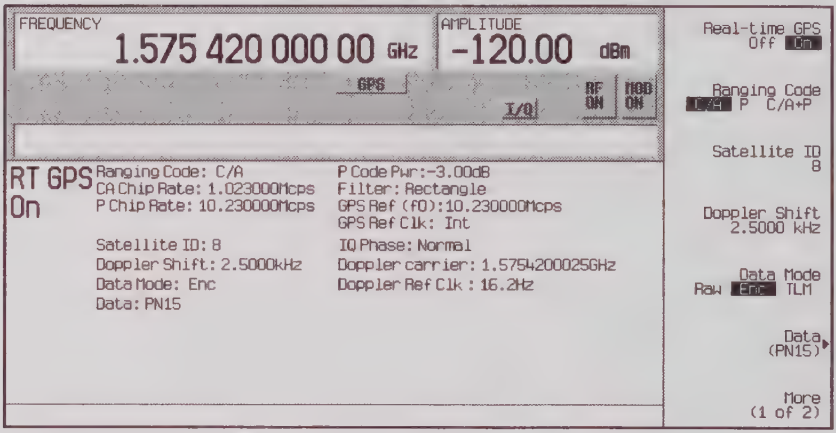
   To create a user file, refer to "Creating a User File" on page 183.
7. Press **Real-time GPS Off On** to On.
8. Press the **Frequency** hardkey. Using the numeric keypad, set the signal generator RF output frequency to 1.57542 GHz (L1 carrier frequency).
9. Press the **Amplitude** hardkey. Using the numeric keypad, set the signal generator RF output amplitude to –120 dBm.
10. Turn the RF output on by pressing the **RF On/Off** hardkey on the signal generator front panel.

The real-time GPS signal is now available at the signal generator RF OUTPUT connector. Figure 5-22 on page 190 shows what the signal generator display should like after all steps have been completed. Notice the GPS, I/Q, and RF ON annunciators are on and the parameter settings for the signal are displayed in the status area of the signal generator display.

This task sets up a GPS signal that incorporates a subframe structure using 10 words, each with 24 raw data bits and 6 parity bits computed from the data source. This subframe structure was accomplished by selecting Enc as the data mode and using a PN15 sequence. The PN15 sequence was encoded with the C/A code at 50 bps. Using factory preset settings,

the C/A chip rate is 1.023 Mcps with a clock reference of 10.23 Mcps. A 2.5 kHz doppler shift was added to simulate the relative motion of the satellite with respect to the receiver. For more information on the GPS option, refer to "GPS" on page 348.

Figure 5-22



Configuring the External Reference Clock

1. Access the real-time GPS personality.
2. Press **More (1 of 2) > GPS Ref Clk Ext Int** to Ext.
3. Press **GPS Ref (f0) > 11.03 > kcps.**
4. Connect the external reference clock source to the DATA CLOCK INPUT connector.

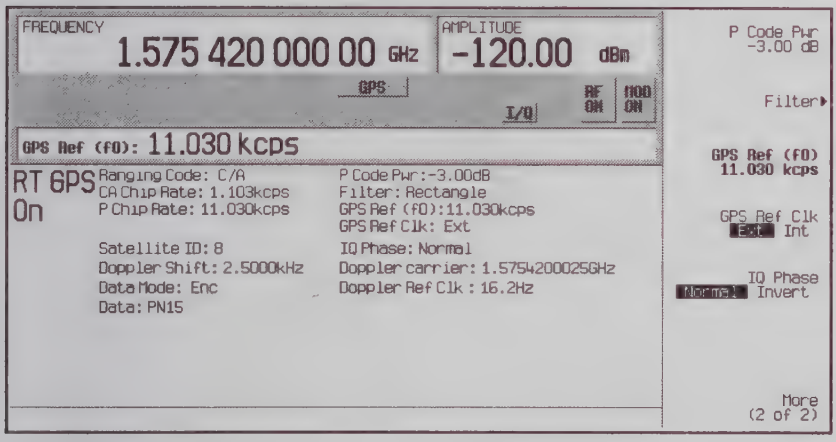
   The maximum clock rate for this input connector is 50 MHz with a voltage range of -0.5 to 5.5 V.
5. Set the external reference clock source to the chip rate value entered in3.

   The maximum data rate for this input connector is 50 Mb/s with a voltage range of -0.5 to 5.5 V.

NOTE The chip rate of the external source must match the chip rate value set using the **GPS Ref (f0)** softkey.

Figure 5-23 on page 191 shows what the signal generator display should look like after all the steps have been completed. The `CA Chip Rate`, `P Chip Rate`, `GPS Ref (f0)`, and `GPS Ref Clk` fields ,in the status area of the display, show the new parameters for this external reference procedure. Notice the settings `Satellite ID`, `Doppler Shift`, `Data`, and `Data Mode`, reflect the steps in the previous procedure, "Setting Up the GPS Signal" on page 189.

Figure 5-23



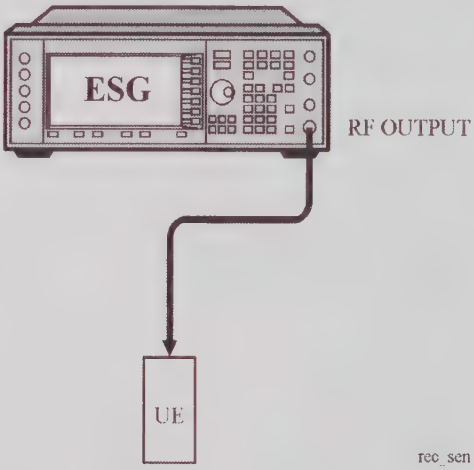
This task supplied an external source for use as the reference clock signal. In addition, the expected reference frequency was modified from the GPS standard of 10.23 Mcps to 11.03 kcps. This change in the reference signal frequency also affects the P and C/A code chip rates. Since the P code chip rate matches the reference frequency, its chip rate is now 11.03 kcps and the C/A code, which is one-tenth of the reference frequency, is now 1.103 kcps. For more information on the GPS option, refer to "GPS" on page 348.

Testing Receiver Sensitivity

Refer to Figure 5-24.

1. Connect the cables between the receiver and the ESG as shown in Figure 5-24.

Figure 5-24 Setup for a Receiver Sensitivity Test



2. Set the GPS data mode to TLM.
3. Set the power level on the ESG.
4. Set the L-band frequency on the ESG.
5. Set up the UE (user equipment) to receive the signal from the ESG.
6. Turn on the GPS personality and the RF output on the ESG.

6 Specialized Digital Modulation

AWGN Waveforms

Using the AWGN menu, you can define and generate additive white gaussian noise waveforms. AWGN waveforms are generated by the dual arbitrary waveform generator.

Configuring the AWGN Generator

1. Press **Preset**.
2. Press **Mode** > **More (1 of 2)** > **AWGN** > **Arb Waveform Generator AWGN**
3. Press **Bandwidth** > **1.25** > **MHz**.
4. Press **Waveform Length** > **131072**.
5. Press **Noise Seed Fixed Random** until Random is highlighted.

This configures a randomly seeded AWGN waveform with a bandwidth of 1.25 MHz and a waveform length of 131072 bits.

Generating the Waveform

Press **AWGN Off On** until On is highlighted.

This generates an AWGN waveform with the parameters defined in the previous section. During waveform generation, the `AWGN` and `I/Q` annunciators activate and the AWGN waveform is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **500** > **MHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off**.

The AWGN waveform is now available at the signal generator's RF OUTPUT connector.

Multitone Waveforms

Using the `Multitone Setup` table editor, you can define, modify and store user-defined multitone waveforms. Multitone waveforms are generated by the dual arbitrary waveform generator.

Creating a Custom Multitone Waveform

This section teaches you how to perform the following tasks:

- "Initializing the Multitone Setup Table Editor" on page 195
- "Configuring Tone Powers and Tone Phases" on page 195
- "Removing a Tone" on page 196
- "Generating the Waveform" on page 196
- "Configuring the RF Output" on page 196

Initializing the Multitone Setup Table Editor

1. Press **Preset**.
2. Press **Mode** > **More (1 of 2)** > **Multitone**
3. Press **Initialize Table** > **Number of Tones** > **5** > **Enter**.
4. Press **Freq Spacing** > **20** > **kHz**.
5. Press **Done**.

You now have a multitone setup with five tones spaced 20 kHz apart. The center tone is placed at the carrier frequency, while the other four tones are spaced in 20 kHz increments from the center tone.

Configuring Tone Powers and Tone Phases

1. Highlight the value (`0 dB`) in the `Power` column for the tone in row 2.
2. Press **Edit Item** > **–4.5** > **dB**.
3. Highlight the value (`0`) in the `Phase` column for the tone in row 2.
4. Press **Edit Item** > **123** > **deg**.

Removing a Tone

1. Highlight the value (On) in the State column for the tone in row 4.
2. Press **Toggle State**.

Generating the Waveform

Press **Multitone Off On** until On is highlighted.

This generates the multitone waveform with the parameters defined in the previous sections. During waveform generation, the M-TONE and I/Q annunciators activate and the multitone waveform is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **100** > **MHz**.
2. Press **Amplitude** > **0** > **dBm**.
3. Press **RF On/Off**.

The multitone waveform is now available at the signal generator's RF OUTPUT connector.

Applying Changes to an Active Multitone Signal

If the multitone generator is currently in use (**Multitone Off On** set to On) while changes are made in the Multitone Setup table editor, you must *apply* the changes before the updated waveform will be generated.

From the Multitone Setup table editor, press the following key to apply the changes and generate a multitone waveform based on the updated values:

Apply Multitone

Storing a Multitone Waveform

In this example, you learn how to store a multitone waveform. If you have not created a multitone waveform, complete the steps in the previous section, "Creating a Custom Multitone Waveform" on page 195.

1. Press **More (1 of 2)** > **Load/Store** > **Store To File**.

   If there is already a file name from the Catalog of MTONE Files occupying the active entry area, press the following keys:

   Edit Keys > **Clear Text**

2. Enter a file name (for example, 5TONE) using the alpha keys and the numeric keypad.
3. Press **Enter**.

The multitone waveform is now stored in the `Catalog of MTONE Files`.

NOTE The RF output amplitude, frequency, and operating state settings are not stored as part of a multitone waveform file.

Recalling a Multitone Waveform

Using this procedure, you learn how to recall a multitone waveform from the signal generator's memory catalog.

If you have not created and stored a multitone waveform, complete the steps in the previous sections, "Creating a Custom Multitone Waveform" on page 195 and "Storing a Multitone Waveform" on page 196, then preset the signal generator to clear the stored multitone waveform from volatile ARB memory.

1. Press **Mode** > **Multitone**.
2. Press **More (1 of 2)** > **Load/Store**.
3. Highlight the desired file (for example, 5TONE).
4. Press **Load From Selected File** > **Confirm Load From File**.
5. Press **More (2of 2)** > **Multitone Off On** until On is highlighted.

The firmware generates the multitone waveform in ARB memory. After waveform generation, the multitone waveform is available to be modulated on the RF output.

For instruction on configuring the RF output, see "Configuring the RF Output" on page 196.

Custom Modulation

The custom format enables you to create unframed digital modulation with user-defined data, filtering, symbol rate, modulation type, burst shape, differential data encoding, and other format parameters.

You can choose a predefined mode where filtering, symbol rate and modulation type are defined by the selected digital modulation standard, or a user-defined custom modulation.

Selecting Predefined Custom Modulation Modes

1. Press **Preset**.
2. Press **Mode** > **Custom** > **Real Time I/Q Base Band**.
3. Press **More (1 of 3)** > **More (2 of 3)** > **Predefined Mode** > **APCO 25 w/C4FM**.
4. Press **More (3 of 3)**.

   This selects a predefined mode where filtering, symbol rate and modulation type are defined by the APCO 25 w/C4FM digital modulation standard and returns you to the top-level custom modulation menu. To configure data, burst shape, and differential data encoding parameters, see the next section, "Creating User-Defined Custom Modulation."

   To output this predefined custom modulation, complete the steps in "Generating the Waveform" on page 200 and "Configuring the RF Output" on page 200.

NOTE To deselect a predefined mode, press the following keys:

Mode > **Custom** > **Real Time I/Q Base Band** > **More (1 of 3)** > **More (2 of 3)** > **Predefined Mode** > **None**

Creating User-Defined Custom Modulation

This section teaches you how to perform the following tasks:

- "Selecting Data" on page 199
- "Configuring the Filter" on page 199
- "Selecting a Symbol Rate" on page 199
- "Selecting the Modulation Type" on page 199

- "Configuring the Burst Rise and Fall Parameters" on page 199
- "Activating Differential Data Encoding" on page 200
- "Generating the Waveform" on page 200
- "Configuring the RF Output" on page 200

Selecting Data

1. Press **Preset**.
2. Press **Mode** > **Custom** > **Real Time I/Q Base Band** > **Data** > **FIX4**.
3. Press **1010** > **Enter** > **Return**.

Configuring the Filter

1. Press **Filter** > **Select** > **Gaussian**.
2. Press **Filter BbT**.
3. Press **.45** > **Enter** > **Return**.

Selecting a Symbol Rate

1. Press **Symbol Rate**.
2. Press **25** > **ksps** > **Return**.

Selecting the Modulation Type

Press **Modulation Type** > **Select** > **QAM** > **32QAM** > **Return**.

For information on user-defined I/Q mapping, see "User-Defined I/Q Maps" on page 201. For information on user-defined FSK modulation, see "User-Defined FSK Modulation" on page 205.

Configuring the Burst Rise and Fall Parameters

1. Press **Burst Shape** > **Rise Time**.
2. Press **5.202** > **bits**.
3. Press **Rise Delay** > **.667** > **bits**.
4. Press **Fall Time** > **4.8** > **bits**.
5. Press **Fall Delay** > **.667** > **bits**.

This configures the burst shape for the custom real-time I/Q baseband digital modulation format. For instructions on creating and applying user-defined burst shape curves, see "Using Customized Burst Shape Curves" on page 228.

Activating Differential Data Encoding

Press **Return**

Press **More (1 of 3) > Diff Data Encode Off On**.

This activates differential data encoding for the current real-time I/Q baseband digital modulation format. For more information, see "Differential Data Encoding" on page 333.

To generate and output the custom digital modulation, complete the steps in the following sections.

Generating the Waveform

Press **More (2 of 3) > More (3 of 3)**

Press **Custom Off On** until On is highlighted.

This generates the custom real-time I/Q baseband waveform with the parameters defined in the previous sections. During waveform generation, the `CUSTOM` and `I/Q` annunciators activate and the custom waveform is stored in pattern RAM. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency > 500 > MHz**.
2. Press **Amplitude > 0 > dBm**.
3. Press **RF On/Off**.

The custom real-time I/Q baseband waveform is now available at the signal generator's RF OUTPUT connector.

User-Defined I/Q Maps

In modulation schemes defined by standards (such as TDMA and CDMA), symbols appear in default positions in the I/Q plane. Using the `I/Q Values` table editor, you can define your own symbol map by changing the position of one or more symbols. The `I/Q Values` is available for custom real-time I/Q baseband generator waveforms and real-time I/Q baseband generator TDMA waveforms. It is not available for waveforms generated by the dual arbitrary waveform generator.

Creating a User-Defined I/Q Map

This section teaches you how to perform the following tasks:

- "Accessing and Clearing the I/Q Table Editor" on page 201
- "Entering I and Q Values" on page 202
- "Displaying the I/Q Map" on page 202

Use the following procedure to create and store a 4-symbol unbalanced QPSK modulation.

Accessing and Clearing the I/Q Table Editor

1. Press **Preset**.
2. Perform the following keypress sequence required for your format type.

For Custom Format

Press **Mode** > **Custom** > **Real Time I/Q Base Band** > **Modulation Type** > **Define User I/Q** > **More (1 of 2)** > **Delete All Rows** > **Confirm Delete All Rows**.

For TMDA Formats

Press **Mode** > **TDMA** > ***desired format*** > **More (1 of 2)** > **Modify Standard** > **Modulation Type** > **Define User I/Q** > **More (1 of 2)** > **Delete All Rows** > **Confirm Delete All Rows**.

This loads a default 4QAM I/Q modulation and clears the `I/Q Values` table editor.

Entering I and Q Values

Enter the I and Q values listed in the following table.

Symbol	Data Bits	I Value	Q Value
0	0000	0.500000	1.000000
1	0001	–0.500000	1.000000
2	0010	0.500000	–1.000000
3	0011	–0.500000	–1.000000

1. Press **.5** > **Enter**.
2. Press **1** > **Enter**.
3. Enter the remaining I and Q values.

As the I value updates, the highlight moves to the first Q entry (and provides a default value of 0), and an empty row of data appears below the first row. As the Q value updates, and the highlight moves to the next I value. As you press the numeric keys, the numbers display in the active entry area. If you make a mistake, use the backspace key and then retype.

Also note that `0.000000` appears as the first entry in the list of `Distinct Values`, and that `0.500000` and `1.000000` are listed as the distinct values.

Displaying the I/Q Map

1. Press **Return** > **Display I/Q Map**

   An I/Q map generated using the current values in the `I/Q Values` table editor is displayed.

   The map in this example has four symbols. The map uses the following *four* unique values: 0.5, 1.0, –0.5, and –1.0 to create the four symbols. It is not the number of values that defines how many symbols a map has, but how those values are combined.

2. Press **Return**.

   When the contents of a table editor have not been stored, `I/Q Values (UNSTORED)` appears on the display. Follow the instructions in the next section to store the custom I/Q table.

Storing a User-Defined I/Q Map File

In this example, you learn how to store a user-defined I/Q map. If you have not created a user-defined I/Q map, complete the steps in the previous sections, "Accessing and Clearing the I/Q Table Editor" on page 201 and "Entering I and Q Values" on page 202.

1. Press **More (1 of 2)** > **Load/Store** > **Store To File**.

   If there is already a file name from the `Catalog of IQ Files` occupying the active entry area, press the following keys:

   Edit Keys > **Clear Text**

2. Enter a file name (for example, `NEW4QAM`) using the alpha keys and the numeric keypad.
3. Press **Enter**.

The user-defined I/Q map is now stored in the `Catalog of IQ Files`.

Moving I/Q Symbols

This section teaches you how to perform the following tasks:

- "Loading the Default 4QAM I/Q Map" on page 203
- "Editing I and Q Values" on page 204
- "Displaying the I/Q Map" on page 204

Use the following procedure to manipulate symbol locations to simulate magnitude and phase errors. In this example, you edit a 4QAM constellation to move one symbol closer to the origin.

Loading the Default 4QAM I/Q Map

1. Press **Preset**.
2. Perform the following keypress sequence required for your format type.

   For Custom Format

   Press **Mode** > **Custom** > **Real Time I/Q Base Band** > **Modulation Type** > **Define User I/Q** > **More (1 of 2)** > **Load Default I/Q Map** > **QAM** > **4QAM**.

   For TMDA Formats

   Press **Mode** > **TDMA** > ***desired format*** > **More (1 of 2)** > **Modify Standard** > **Modulation Type** > **Define User I/Q** > **More (1 of 2)** > **Load Default I/Q Map** > **QAM** > **4QAM**.

   This loads a default 4QAM I/Q modulation into the `I/Q Values` table editor.

Editing I and Q Values

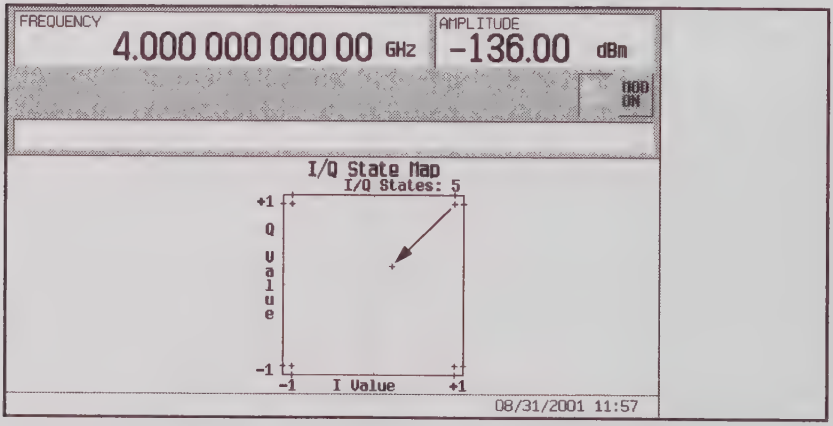
1. Press **.235702 > Enter**.
2. Press **.235702 > Enter**.

   As you enter the numbers using the numeric keypad, they are displayed in the active entry area. If you make a mistake, use the backspace key and then retype. The I value updates and the highlight moves to the first Q entry. Next, the Q value updates and the highlight moves to the following I entry.

Displaying the I/Q Map

Press **More (2 of 2) > Display I/Q Map**.

Note that one symbol has moved, as shown.



For instructions on storing this modified I/Q map to the signal generator's memory catalog, see "Storing a User-Defined I/Q Map File" on page 203.

User-Defined FSK Modulation

Using the Frequency Values table editor, you can define, modify and store user-defined frequency shift keying modulation.

The Frequency Values table editor is available for custom real-time I/Q baseband generator waveforms and real-time I/Q baseband generator TDMA waveforms. It is not available for waveforms generated by the dual arbitrary waveform generator.

Modifying a Default FSK Modulation

In this example, you learn how to add errors to a default FSK modulation.

This section teaches you how to perform the following tasks:

- "Loading the Default 4-Level FSK" on page 205
- "Modifying Frequency Deviation Values" on page 206

Loading the Default 4-Level FSK

1. Press **Preset**.
2. Perform the following keypress sequence required for your format type.

   For Custom Format

   Press **Mode** > **Custom** > **Real Time I/Q Base Band** > **Modulation Type** > **Define User FSK** > **More (1 of 2)** > **Load Default FSK**.

   For TMDA Formats

   Press **Mode** > **TDMA** > ***desired format*** > **More (1 of 2)** > **Modify Standard** > **Modulation Type** > **Define User FSK** > **More (1 of 2)** > **Load Default FSK**.
3. Press **Freq Dev** > **1.8** > **kHz**.
4. Press **4-Lvl FSK**.

   This sets the frequency deviation and opens the Frequency Values table editor with the 4-level FSK default values displayed. The frequency value for data 0000 is highlighted.

Modifying Frequency Deviation Values

1. Press **-1.81 > kHz**.
2. Press **-590 > Hz**.
3. Press **1.805 > kHz**.
4. Press **610 > Hz**.

As you modify the frequency deviation values, the cursor moves to the next data row. An unstored file of frequency deviation values is created for your custom 4-level FSK file. For instructions on storing the file, see the next section.

Storing an FSK Modulation

In this example, you learn how to store an FSK modulation. If you have not created an FSK modulation, complete the steps in the previous section, "Modifying a Default FSK Modulation" on page 205.

1. Press **Load/Store > Store To File**.

   If there is already a file name from the `Catalog of FSK Files` occupying the active entry area, press the following keys:

   Edit Keys > Clear Text

2. Enter a file name (for example, `NEWFSK`) using the alpha keys and the numeric keypad.
3. Press **Enter**.

The user-defined FSK modulation is now stored in the `Catalog of FSK Files`.

Creating a User-Defined FSK Modulation

This section teaches you how to perform the following tasks:

- "Accessing and Clearing the Table Editor" on page 206
- "Entering Frequency Deviation Values" on page 207

Accessing and Clearing the Table Editor

1. Press **Preset**.

2. Perform the following keypress sequence required for your format type.

   For Custom Format

   Press **Mode** > **Custom** > **Real Time I/Q Base Band** > **Modulation Type** > **Define User FSK** > **More (1 of 2)** > **Delete All Rows** > **Confirm Delete All Rows**.

   For TMDA Formats

   Press **Mode** > **TDMA** > ***desired format*** > **More (1 of 2)** > **Modify Standard** > **Modulation Type** > **Define User FSK** > **More (1 of 2)** > **Delete All Rows** > **Confirm Delete All Rows**.

   This accesses the `Frequency Values` table editor and clears the previous values.

Entering Frequency Deviation Values

3. Press **600** > **Hz**.
4. Press **1.8** > **kHz**.
5. Press **–600** > **Hz**.
6. Press **–1.8** > **kHz**.

This sets the frequency deviation for data `0000`, `0001`, `0010`, and `0011` to configure a user-defined FSK modulation. Each time you enter a value, the `Data` column increments to the next binary number, up to a total of 16 data values (from `0000` to `1111`).

For instructions on storing this user-defined FSK modulation to the memory catalog, see "Storing an FSK Modulation" on page 206.

7 Controlling Digital Modulation Output

Using the Waveform Sequencer

The waveform sequencer can "play" an ordered series of individual waveforms. Waveforms can be generated using the dual arbitrary waveform generator, renamed as "waveform segments," and built into user-defined waveform sequences that are modulated to the RF output. The waveform sequencer is not available for real-time I/Q baseband generated waveforms.

Waveform sequencer features include waveform clipping, markers, and triggering useful for synchronizing the output of the signal generator with other devices.

Creating Waveform Segments

There are two ways to provide waveform segments for use by the waveform sequencer. You can either download a waveform via remote interface or generate a waveform using the dual arbitrary waveform generator. For information on downloading waveforms via remote interface, see the programming guide.

The following procedure shows you how to create waveform segments using IS-95A CDMA waveforms. For information on generating waveforms using other digital communications formats, refer to Chapter 4, "Digital Modulation for Component Test," on page 71. For information on generating AWGN and multitone waveforms, refer to Chapter 6, "Specialized Digital Modulation," on page 193.

In this example, you generate two IS-95A CDMA waveform segments, a predefined 64 channel forward CDMA state and a predefined 9 channel forward CDMA state. After the two waveform segments are named and stored in ARB memory, they are used to build a waveform sequence in the following section.

This section teaches you how to perform the following tasks:

- "Generating the First Waveform" on page 211
- "Creating the First Waveform Segment" on page 211
- "Generating the Second Waveform" on page 211
- "Creating the Second Waveform Segment" on page 212

Generating the First Waveform

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb IS-95A**.
3. Press **Setup Select** > **64 Ch Fwd**.
4. Press **CDMA Off On** until **On** is highlighted.

   This generates a waveform with the predefined 64 channel forward CDMA state created in the previous section. During waveform generation, the CDMA and I/Q annunciators activate. The 64 channel forward waveform is stored in volatile ARB memory with the default file name AUTOGEN_WAVEFORM, as you will see in the next section.

NOTE There can only be one AUTOGEN_WAVEFORM waveform in ARB memory at any given time.

Therefore, you must rename this file, clearing the way for a second CDMA waveform.

Creating the First Waveform Segment

1. Press **Return** > **Return** > **Dual ARB**.
2. Press **Waveform Segments**.
3. Press **Load Store** until **Store** is highlighted.
4. Highlight the default segment AUTOGEN_WAVEFORM.
5. Press **More (1 of 2)** > **Rename Segment** > **Editing Keys** > **Clear Text**.
6. Enter a file name (for example, 64CHF) using the alpha keys and the numeric keypad.
7. Press **Enter**.

Generating the Second Waveform

1. Press **Mode** > **CDMA** > **Arb IS-95A**.
2. Press **Setup Select** > **9 Ch Fwd**.

Because **CDMA Off On** is set to **On**, the signal generator automatically generates a new waveform with the predefined 9 channel forward CDMA state. During waveform generation, the CDMA and I/Q annunciators activate. The 9 channel forward waveform is stored in volatile ARB memory with the default file name AUTOGEN_WAVEFORM.

Creating the Second Waveform Segment

1. Press **Return** > **Return** > **Dual ARB**.
2. Press **Waveform Segments**.
3. Press **Load Store** until **Store** is highlighted.
4. Highlight the default segment AUTOGEN_WAVEFORM.
5. Press **More (1 of 2)** > **Rename Segment** > **Editing Keys** > **Clear Text**.
6. Enter a file name (for example, 9CHF) using the alpha keys and the numeric keypad.
7. Press **Enter**.

The waveform segments (for example, 64CHF and 9CHF) are now stored in volatile ARB memory.

Building a Waveform Sequence

In this example, you learn how to build a waveform sequence using two waveform segments. If you have not created the waveform segments used to build a waveform sequence, complete the steps in the previous section, "Creating Waveform Segments" on page 210.

This section teaches you how to perform the following tasks:

- "Creating a Waveform Sequence Using Waveform Segments" on page 212
- "Editing Waveform Segment Repetition" on page 213

Creating a Waveform Sequence Using Waveform Segments

1. Press **Mode** > **Dual ARB** > **Waveform Sequences**
2. Press **Build New Waveform Sequence** > **Insert Waveform**.
3. Highlight the first waveform segment (for example, 64CHF).
4. Press **Insert Selected Waveform**.
5. Highlight the second waveform segment (for example, 9CHF).
6. Press **Insert Selected Waveform**.
7. Press **Done Inserting**.
8. Press **Name and Store**.
9. Enter a file name (for example, 64CHF+9CHF) using the alpha keys and the numeric keypad.

10. Press **Enter**.
11. Press **Return** > **Return** > **Select Waveform**.
12. Highlight the waveform sequence you just created (for example, `64CHF+9CHF`).
13. Press **Select Waveform**.
14. Press **ARB Off On** until **On** is highlighted.
15. Press **Waveform Segments** > **Load Store** > **Waveform Utilities** > **Set Markers** > **Set Marker On First Point**.
16. Press **Return** > **Scale Waveform Data** > **Scaling** > **98** > **%** > **Apply to Waveform**.
17. Press **Clipping** > **Clip |I+jQ| To** > **98** > **%** > **Apply to Waveform**.
18. Press **Return** > **Return**.

The sequence has now been defined as one repetition of the 64 channel forward CDMA waveform segment followed by one repetition of the 9 channel forward CDMA waveform segment.

Because the second waveform was highlighted when the markers were set, marker 1 has been set to output at the EVENT 1 connector at the first point of the second waveform segment. The second waveform's scaling has been set to 98% of its full-scale value and it is being clipped at 98% of its highest peak.

For additional information on setting waveform markers, waveform scaling, and waveform clipping, see "Using Waveform Markers" on page 218, "Waveform Scaling" in the concept chapter, and "Using Waveform Clipping" on page 216, respectively.

Editing Waveform Segment Repetition

1. Press **Select Waveform**.
2. Highlight the first waveform sequence entry (for example, `ARB:64CHF+9CHF`).
3. Press **Return** > **Waveform Sequences** > **Edit Selected Waveform Sequence**.
4. Highlight the first waveform sequence entry (for example, `WFM:64CHF`).
5. Press **Edit Repetitions** > **100** > **Enter**.
6. Press **Edit Repetitions** > **200** > **Enter**.

The number of repetitions for the first waveform sequence entry changes to `100` and the cursor moves to the next sequence entry where 200 is entered. The waveform sequence has been defined as 100 repetitions of the first waveform segment followed by 200 repetitions of the second waveform segment.

Storing a Waveform Sequence

In this example, you learn how to store a waveform sequence. If you have not created waveform segments and used them to build a waveform sequence, complete the steps in the previous sections, "Creating Waveform Segments" on page 210 and "Building a Waveform Sequence" on page 212.

1. Press **Name And Store**.

   If there is already a file name from the `Catalog of Seq Files` occupying the active entry area, press the following keys:

   Editing Keys > **Clear Text**

2. Enter a file name (for example, `64CHF100_9CHF200`) using the alpha keys and the numeric keypad.
3. Press **Enter**.

The sequence is stored to the `Catalog of Seq Files` in the signal generator's memory catalog.

Playing a Waveform Sequence

In this example, you learn how to play a waveform sequence. If you have not created waveform segments and used them to build and store a waveform sequence, complete the steps in the previous sections, "Creating Waveform Segments" on page 210, "Building a Waveform Sequence" on page 212, and "Storing a Waveform Sequence" on page 214.

This section teaches you how to perform the following tasks:

- "Selecting a Waveform Sequence" on page 214
- "Generating the Waveform" on page 215
- "Configuring the RF Output" on page 215

Selecting a Waveform Sequence

1. Press **Return** > **Return** > **Select Waveform**.
2. Highlight a waveform (for example, `64CHF100_9CHF200`) from the `Sequence` column of the `Select Waveform` catalog.
3. Press **Select Waveform**.

The display shows the currently selected waveform (for example, `Selected Waveform: SEQ:64CHF100_9CHF200`).

Generating the Waveform

Press **ARB Off On** until **On** is highlighted.

This generates the waveform sequence created in the previous sections. During waveform sequence generation, the ARB and I/Q annunciators activate and the sequence is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **890.01** > **MHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off** hardkey.

The waveform sequence is now available at the signal generator's RF OUTPUT connector.

Using Waveform Clipping

Clipping limits power peaks in waveform segments by clipping the I and Q data to a selected percentage of its highest peak. *Circular* clipping is defined as clipping the composite I/Q data (I and Q data are equally clipped). *Rectangular* clipping is defined as independently clipping the I and Q data. For more information, see "Waveform Clipping" on page 316.

In this section, you learn how to clip waveform segments. If you have not created waveform segments, complete the steps in the previous section, "Creating Waveform Segments" on page 210.

Configuring Circular Clipping

1. Press **Mode** > **Dual ARB** > **Waveform Segments**.
2. Press **Load Store**.
3. Highlight the first waveform segment (for example, `64CHF`).
4. Press **Waveform Utilities** > **Clipping**.
5. Press **Clip |I+jQ| To** > **80** > **%**.

   During waveform generation, the I and Q data are both clipped by 80%. `80.0%` is shown below the **Clip |I+jQ| To** softkey.
6. Press **Return** > **Return** > **Return** > **Arb Off On** until **On** is highlighted to generate the clipped waveform segment.

Configuring Rectangular Clipping

1. Press **Mode** > **Dual ARB** > **Waveform Segments**.
2. Press **Load Store**.
3. Highlight the second waveform segment (for example, `9CHF`).
4. Press **Waveform Utilities** > **Clipping**.
5. Press **Clipping Type |I+jQ| |I|,|Q|**.

   This activates the **Clip |I| To** and **Clip |Q| To** softkeys that allow you to configure rectangular (independent) I and Q data clipping.
6. Press **Clip |I| To** > **80** > **%**.
7. Press **Clip |Q| To** > **40** > **%**.

8. Press **Return** > **Return** > **Return** > **Arb Off On** until **On** is highlighted to generate the clipped waveform segment.

Applying Clipping Modifications to an Active Waveform Sequence

If the waveform segment is currently in use (**ARB Off On** set to **On**) while changes are made to clipping values, you must *apply* the changes before the updated waveform will be generated.

Press **Apply To Waveform**.

This applies the modified clipping values and generates a new waveform segment based on the updated values.

Using Waveform Markers

Waveform markers provide auxiliary output signals synchronized with a waveform segment. The signal generator has two markers that you can place on a waveform segment. Using markers, you can construct these output signals as a trigger to synchronize another instrument to a given portion of a waveform.

You can also place markers into a waveform sequence, either as the sequence is being built or within an existing waveform sequence.

Placing a Marker at the First Point within a Waveform Segment

If you have not created a waveform segment, complete the steps in the previous sections, "Generating the First Waveform" on page 211 and "Creating the First Waveform Segment" on page 211.

1. Press **Mode** > **Dual ARB** > **Waveform Segments**.
2. Press **Load Store**.
3. Highlight a waveform segment (for example, `64CHF`).
4. Press **Waveform Utilities** > **Set Markers** > **Set Marker On First Point**.

This sets Marker 1 (selected by default) on the first point in the selected waveform segment. For instructions on verifying marker operation, see "Verifying Marker Operation" on page 222.

Placing a Marker Across a Range of Points within a Waveform Segment

If you have not created a waveform segment, complete the steps in the previous sections, "Generating the First Waveform" on page 211 and "Creating the First Waveform Segment" on page 211.

1. Press **Mode** > **Dual ARB** > **Waveform Segments**.
2. Press **Load Store**.
3. Highlight a waveform segment (for example, `64CHF`).
4. Press **Waveform Utilities** > **Set Markers** > **Set Marker On Range Of Points**.
5. Press **First Mkr Point** > **10** > **Enter**.

6. Press **Last Mkr Point** > **163830** > **Enter**.
7. Press **Apply To Waveform**.

NOTE If you enter a value for either the first marker point or the last marker point that would make the first marker point occur *after* the last, the last marker point is automatically adjusted to match the first marker point.

This activates Marker 1 (selected by default) between the 9^{th} point and the 163831^{th} point in the selected waveform segment.

For instructions on verifying marker operation, see "Verifying Marker Operation" on page 222.

Placing Repetitively Spaced Markers within a Waveform Segment

If you have not created a waveform segment, complete the steps in the previous sections, "Generating the First Waveform" on page 211 and "Creating the First Waveform Segment" on page 211.

1. Press **Mode** > **Dual ARB** > **Waveform Segments**.
2. Press **Load Store**.
3. Highlight a waveform segment (for example, `64CHF`).
4. Press **Waveform Utilities** > **Set Markers** > **Set Marker On Range Of Points**.
5. Press **First Mkr Point** > **10** > **Enter**.
6. Press **Last Mkr Point** > **163830** > **Enter**.
7. Press **# Skipped Points** > **2** > **Enter**.
8. Press **Apply To Waveform**.

NOTE If you enter a value for either the first marker point or the last marker point that would make the first marker point occur *after* the last, the last marker point is automatically adjusted to match the first marker point.

This activates Marker 1 (selected by default) every three points between the 9^{th} point and the 163831^{th} point in the selected waveform segment.

For instructions on verifying marker operation, see "Verifying Marker Operation" on page 222.

Using Marker 2 to Blank the RF Output

If you have not created a waveform segment, complete the steps in the previous sections, "Generating the First Waveform" on page 211 and "Creating the First Waveform Segment" on page 211.

NOTE Marker 2 to Blank RF Output applies to Marker 2 only. Marker 1 does not blank the RF output. For more information, see "Waveform Markers" on page 324.

---

1. Press **Preset**.
2. Press **Mode** > **Dual ARB** > **Select Waveform**.
3. Highlight a waveform segment (for example, `64CHF`).
4. Press **Select Waveform**.
5. Press **Mode** > **Dual ARB** > **ARB Setup** > **Marker Polarity Neg Pos** > **Marker 2 To RF Blank Off On**.

NOTE If you leave the marker polarity positive, the RF is blanked *until* the marker goes high. For more information, see "Waveform Clipping" on page 316.

---

6. Press **Return** > **Arb On Off** until **On** is highlighted.
7. Press **Waveform Segments** > **Load Store** > **Waveform Utilities** > **Set Markers** > **Marker 1 2** > **Set Marker On Range of Points**.
8. Press **First Mkr Point** > **10** > **Enter**.
9. Press **Last Mkr Point** > **163830** > **Enter**.
10. Press **Apply To Waveform**.

For instructions on verifying marker operation, see "Verifying Marker Operation" on page 222.

Toggling Markers in an Existing Waveform Sequence

In a waveform sequence, you can independently toggle the operating state of the markers on each waveform segment. When you build a waveform sequence, the markers on each segment are toggled to the last marker operating state that was used.

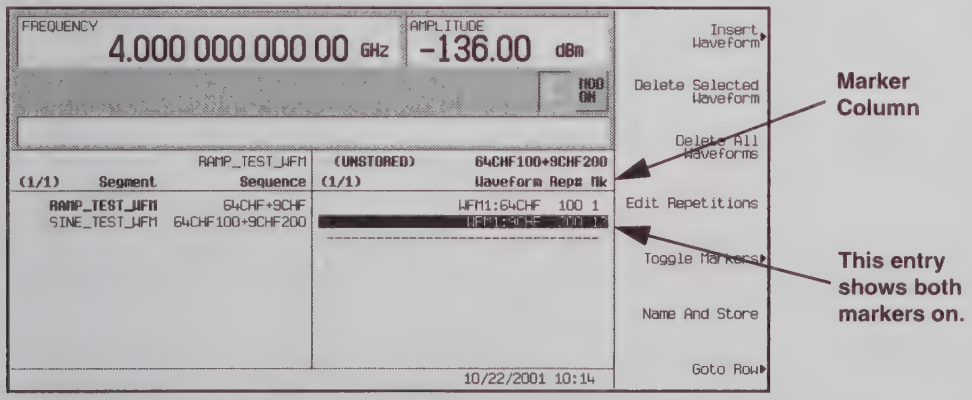
In this example, you learn how to toggle markers within an existing waveform sequence. If you have not created waveform segments, used them to build a waveform sequence, and

stored the waveform sequence, and configured markers for the waveform sequence, complete the steps in the previous sections, "Creating Waveform Segments" on page 210, "Building a Waveform Sequence" on page 212, "Storing a Waveform Sequence" on page 214, and "Placing a Marker at the First Point within a Waveform Segment" on page 218.

1. Press **Mode** > **Dual ARB** > **Waveform Sequences**.
2. Highlight the desired waveform sequence (for example, `64CHF_9CHF`).
3. Press **Edit Selected Waveform Sequence**.
4. Highlight the desired waveform segment (for example, `WFM1:64CHF`).
5. Press **Toggle Markers** > **Toggle Marker 1** or **Toggle Marker 2**.
6. Highlight the next desired waveform segment.
7. Press **Toggle Marker 1** or **Toggle Marker 2**.
8. Repeat steps 6 and 7 until you have finished modifying the desired waveform segments.
9. Press **Return**.

The markers are toggled per your selections.

An entry (`1`, `2`, or `12`) in the `Mk` column indicates that a marker is active. No entry in that column means that both markers are off, as shown.



For instructions on saving the modified waveform sequence, see "Storing a Waveform Sequence" on page 214.

Toggling Markers As You Create a Waveform Sequence

You can combine waveform segments to create a waveform sequence while independently toggling the markers of each waveform segment.

In this example, you learn how to toggle markers while building a waveform sequence. If you have not created waveform segments, complete the steps in the previous section, "Creating Waveform Segments" on page 210.

1. Press **Mode** > **Dual ARB** > **Waveform Sequences** > **Build New Waveform Sequence**.
2. Press **Insert Waveform**.
3. Highlight the desired waveform segment (for example, `64CHF`).
4. Press **Insert Selected Waveform** > **Insert Selected Waveform** > **Insert Selected Waveform** > **Done Inserting**.
5. Highlight the first waveform segment.

   An entry (`1`, `2` or `12`) in the `Mk` column indicates that a marker is active. No entry in that column means that both markers are off.
6. Press **Toggle Markers** > **Toggle Marker 1**.
7. Highlight the next waveform segment.
8. Press **Toggle Marker 2**.
9. Press **Return**.

Marker 2 is on for the first waveform segment and marker 1 is on for the second waveform segment. Marker 1 and 2 are on for the third waveform segment.

Verifying Marker Operation

In this example, you learn how to verify marker operation. If you have not created waveform segments and applied makers, complete the steps in the previous sections, "Creating Waveform Segments" on page 210 and "Placing a Marker at the First Point within a Waveform Segment" on page 218.

Once you set a marker on a waveform segment, you can detect the marker pulse at the EVENT 1 or EVENT 2 connectors (EVENT 1 for this example).

1. Highlight the desired waveform segment.
2. Press **Return** > **Return** to display the Dual ARB softkey menu.
3. Press **ARB Off On** until **On** is highlighted.

4. Connect an oscilloscope input to the EVENT 1 connector, and trigger on the Event 1 signal. When a marker is present, a marker pulse is displayed on the oscilloscope.

Using Waveform Triggers

The dual arbitrary waveform generator includes several different triggering options: single, gated, segment advance, and external.

Using Segment Advance Triggering

Using this procedure, you learn how to control sequence playback of two waveform segments using segment advance triggering.

If you have not created and stored a waveform sequence, complete the steps in the previous sections, "Creating Waveform Segments" on page 210, "Building a Waveform Sequence" on page 212, and "Storing a Waveform Sequence" on page 214.

This section teaches you how to perform the following tasks:

- "Recalling a Waveform Sequence" on page 224
- "Configuring the Waveform Sequence Trigger" on page 224
- "Generating the Waveform Sequence" on page 225
- "Configuring the RF Output" on page 225
- "Monitoring the Current Waveform" on page 225
- "Triggering the Second Waveform" on page 225

Recalling a Waveform Sequence

1. Press **Preset**.
2. Press **Mode** > **Dual ARB** > **Select Waveform**.
3. Highlight the waveform sequence file `64CHF100_9CHF200`.
4. Press **Select Waveform**.

Configuring the Waveform Sequence Trigger

1. Press **Trigger** > **Segment Advance**.
2. Press **Trigger** > **Trigger Setup** > **Trigger Source** > **Trigger Key**.

   This programs the sequencer to stop the playback of the current waveform segment and start the playback of the next waveform segment in the sequence when a trigger is received from the front panel **Trigger** *hardkey*.

Generating the Waveform Sequence

Press **Return** > **Return** > **ARB Off On**.

The first waveform (64CHF) in the sequence is now playing and modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **890.01** > **MHz**.
2. Press **Amplitude** > **-10** > **dBm**.
3. Press **RF On/Off**.

Monitoring the Current Waveform

1. Connect the signal analyzer's input to the output of the signal generator.
2. Adjust the display until you can comfortably observe the complete output of the signal generator's first waveform segment.

Triggering the Second Waveform

1. Press the **Trigger** *hardkey*.
2. Observe the second waveform segment in the sequence (9CHF) is now playing.

Continually pressing the **Trigger** hardkey stops the current waveform playback and start the playback of the other waveform.

Using External Triggering

Using this procedure, you learn how to utilize an external function generator to apply a delayed single-trigger to a custom multicarrier CDMA waveform.

This section teaches you how to perform the following tasks:

- "Connecting the Equipment" on page 226
- "Configuring a Custom Multicarrier CDMA State" on page 226
- "Configuring the Waveform Trigger" on page 226
- "Configuring the Function Generator" on page 226
- "Generating the Waveform" on page 227
- "Configuring the RF Output" on page 227

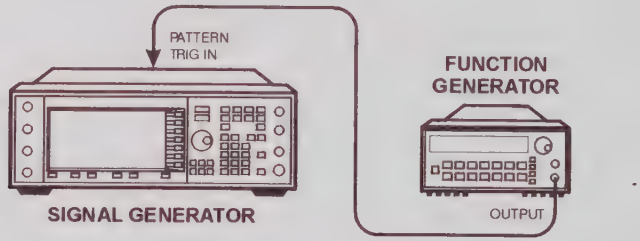
Required Equipment

Agilent 33120A Function Generator

Connecting the Equipment

Connect the signal generator to the function generator, as shown in Figure 7-1.

Figure 7-1



Configuring a Custom Multicarrier CDMA State

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb IS-95A**.
3. Press **Multicarrier Off On**.
4. Press **Setup Select** > **4 Carriers**.

Configuring the Waveform Trigger

1. Press **More (1 of 2)** > **Trigger** > **Single**.
2. Press **Trigger** > **Trigger Setup** >**Trigger Source** > **Ext**.
3. Press **Ext Polarity Neg Pos** until Pos is highlighted.
4. Press **Ext Delay Off On**.
5. Press **Ext Delay Time** > **100** > **msec**.

The waveform will now trigger once 100 milliseconds after it detects a change in TTL state from low to high at the PATT TRIG IN rear panel connector.

Configuring the Function Generator

Set the function generator to waveform to a 0.1 Hz square wave at an output level of 0 to 5V.

Generating the Waveform

Press **Mode** > **CDMA** > **Arb IS-95A** > **CDMA Off On**.

This generates a waveform with the custom multicarrier CDMA state configured in the previous section. The display changes to `Multicarrier Setup: 4CARRIERS`. During waveform generation, the `CDMA` and `I/Q` annunciators activate and the new custom multicarrier CDMA state is stored in volatile ARB memory. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **890.01** > **MHz**.
2. Press **Amplitude** > **-10** > **dBm**.
3. Press **RF On/Off**.

The externally single-triggered custom multicarrier CDMA waveform is now available at the signal generator's RF OUTPUT connector 100 msec after receiving a change in TTL state from low to high at the PATT TRIG IN, provided by the function generator output.

Using Customized Burst Shape Curves

You can adjust the shape of the rise time curve and the fall time curve using the `Rise Shape` and `Fall Shape` editors. Each editor allows you to enter up to 256 values, equidistant in time, to define the shape of the curve. The values are then resampled to create the cubic spline that passes through all of the sample points.

The `Rise Shape` and `Fall Shape` table editors are available for custom real-time I/Q baseband generator waveforms and real-time I/Q baseband generator TDMA waveforms. They are not available for waveforms generated by the dual arbitrary waveform generator.

NOTE You can also design burst shape files externally and download the data to the signal generator. For more information, see the concept chapter.

For instructions on modifying rise and fall times and delays, see "Configuring the Burst Rise and Fall Parameters" on page 199.

Creating a User-Defined Burst Shape Curve

Using this procedure, you learn how to enter rise shape sample values and mirror them as fall shape values to create a symmetrical burst curve.

This section teaches you how to perform the following tasks:

- "Accessing the Table Editors" on page 228
- "Entering Sample Values" on page 229

Accessing the Table Editors

1. Press **Preset**.
2. Perform the following keypress sequence required for your format type.

For Custom Format

Press **Mode** > **Custom** > **Real Time I/Q Base Band** > **Burst Shape**.

For TMDA Formats

Press **Mode** > **Real Time TDMA** > ***desired format*** > **More (1 of 2)** > **Modify Standard** > **Burst Shape**.

3. Press **Define User Burst Shape** > **More (1 of 2)** > **Delete All Rows** > **Confirm Delete Of All Rows**.

Entering Sample Values

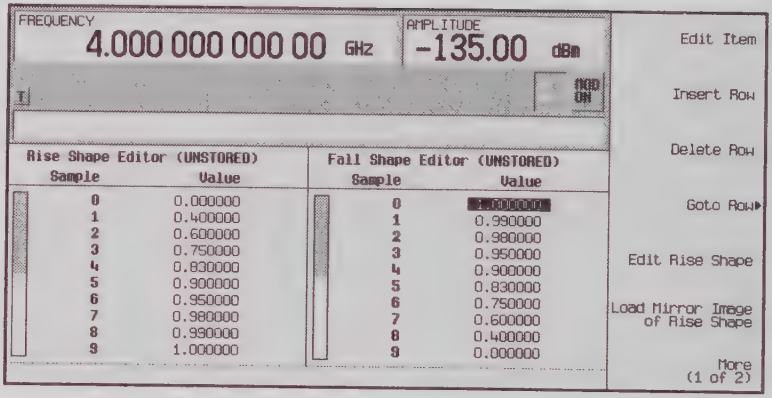
Use the sample values in the following table.

Rise Shape Editor			
Sample	**Value**	**Sample**	**Value**
0	0.000000	5	0.900000
1	0.400000	6	0.950000
2	0.600000	7	0.980000
3	0.750000	8	0.990000
4	0.830000	9	1.000000

1. Highlight the value (`1.000000`) for sample 1.
2. Press **.4** > **Enter**.
3. Press **.6** > **Enter**.
4. Enter the remaining values for samples 3 through 9 from the table above.
5. Press **More (2 of 2)** > **Edit Fall Shape** > **Load Mirror Image of Rise Shape** > **Confirm Load Mirror Image Of Rise Shape**.

   This changes the fall shape values to a mirror image of the rise shape values, as shown in Figure 7-2 on page 230.

Figure 7-2

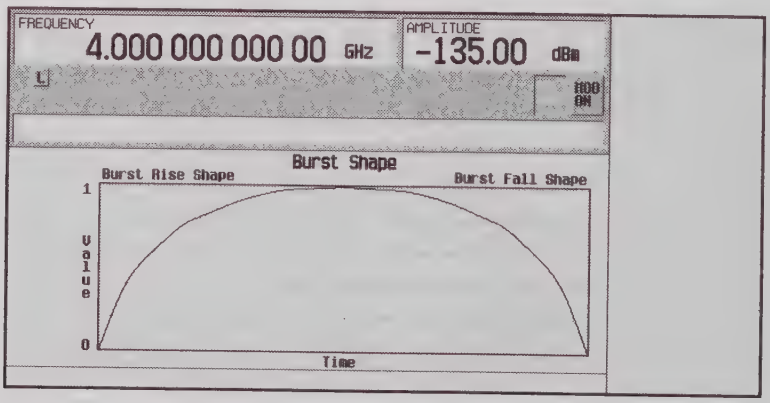


Display the Burst Shape

Press **More (1 of 2)** > **Display Burst Shape**.

This displays a graphical representation of the waveform's rise and fall characteristics, as shown in Figure 7-3.

Figure 7-3



To return the burst to the default conditions, press the following keys:

Return > **Return** > **Confirm Exit From Table Without Saving** > **Restore Default Burst Shape**.

Storing a User-Defined Burst Shape Curve

1. Press **Define User Burst Shape** > **More (1 of 2)** > **Load/Store** > **Store To File**.

   If there is already a file name from the `Catalog of SHAPE Files` occupying the active entry area, press the following keys:

   Editing Keys > **Clear Text**

2. Enter a file name (for example, `NEWBURST`) using the alpha keys and the numeric keypad.
3. Press **Enter**.

The contents of the current `Rise Shape` and `Fall Shape` table editors are stored to the `Catalog of SHAPE Files`. This burst shape can now be used to customize a modulation or as a basis for a new burst shape design.

Recalling a User-Defined Burst Shape Curve

Once a user-defined burst shape file is stored in memory, it can be recalled for use with real-time I/Q baseband generated digital modulation.

This example requires a user-defined burst shape file stored in memory. If you have not created and stored a user-defined burst shape file, complete the steps in the previous sections, "Creating a User-Defined Burst Shape Curve" on page 228 and "Storing a User-Defined Burst Shape Curve" on page 231.

1. Press **Preset**.
2. Perform the following keypress sequence required for your format type.

   For Custom Format

   Press **Mode** > **Custom** > **Real Time I/Q Base Band** > **Burst Shape** > **Burst Shape Type** > **User File**.

   For TMDA Formats

   Press **Mode** > **Real Time TDMA** > ***desired format*** > **More (1 of 2)** > **Modify Standard** > **Burst Shape** > **Burst Shape Type** > **User File**.

3. Highlight the desired burst shape file (for example, `NEWBURST`).
4. Press **Select File**.

   The selected burst shape file is now applied to the current real-time I/Q baseband digital modulation state.

Generating the Waveform

Perform the following keypress sequence required for your format type.

For Custom Format

Press **Return** > **Custom Off On**.

For TMDA Formats

Press **Return** > **Return** > **More (2 of 2)** > ***desired format*** **Off On**.

This generates the custom modulation or TDMA state with user-defined burst shape created in the previous sections. During waveform generation, the CUSTOM (or appropriate TDMA) annunciator and I/Q annunciator activate. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **800** > **MHz**.
2. Press **Amplitude** > **-10** > **dBm**.
3. Press **RF On/Off**.

The current real-time I/Q baseband digital modulation format with user-defined burst shape is now available at the signal generator's RF OUTPUT connector.

Using Finite Impulse Response (FIR) Filters

Finite Impulse Response filters can be created and used with both dual arbitrary waveform generated waveforms and real-time baseband generated waveforms. For this example, the filter is defined within the IS-95A CDMA digital communications format, a dual arbitrary waveform generated state.

Creating a User-Defined FIR Filter

In this procedure, you use the `FIR Values` table editor to create and store an 8-symbol, windowed sinc function filter with an oversample ratio of 4.

This section teaches you how to perform the following tasks:

- "Accessing the Table Editor" on page 233
- "Entering the First 16 Coefficient Values" on page 234
- "Duplicating the First 16 Coefficient Values" on page 234
- "Setting the Oversample Ratio" on page 234
- "Displaying a Graphical Representation of the Filter" on page 235

Accessing the Table Editor

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb IS-95A**.
3. Press **CDMA Define** > **Filter** > **Define User FIR**.

   The `FIR Values` table editor is displayed. The `FIR Values` table editor is used to create filters based on the coefficient values provided. The `Value` field for coefficient 0 is highlighted.

Entering the First 16 Coefficient Values

Coeff.	Value	Coeff.	Value	Coeff.	Value	Coeff.	Value
0	-0.000076	4	0.007745	8	-0.035667	12	0.123414
1	-0.001747	5	0.029610	9	-0.116753	13	0.442748
2	-0.005144	6	0.043940	10	-0.157348	14	0.767329
3	-0.004424	7	0.025852	11	-0.088484	15	0.972149

1. Press **-.000076 > Enter**.

   As you press the numeric keys, the numbers display in the active entry area. If you make a mistake, use the backspace key and then retype.

2. Continue entering the coefficient values from the table above until all 16 are complete.

   In a windowed sinc function filter, the second half of the coefficients are identical to the first half in reverse order. The signal generator provides a mirror table function that automatically duplicates the existing coefficient values in the reverse order.

Duplicating the First 16 Coefficient Values

Press **Mirror Table**.

The last 16 coefficients are automatically generated and the first of these coefficients (number 16) is highlighted.

Setting the Oversample Ratio

Press **Oversample Ratio > 4 > Enter**.

The oversample ratio (OSR) is the number of filter taps per symbol. Acceptable values range from 1 through 32, where the maximum combination of symbols and oversampling ratio is 1024. The instrument hardware, however, is actually limited to 32 symbols, an oversample ratio between 4 and 16, and 256 coefficients. If you enter more than 256 coefficients (but no more than 32 symbols) the instrument will resample to filter within the OSR limits. If the oversample ratio is different from the internal, optimally selected one, then the filter will be resampled to the most optimal oversample ratio.

A FIR filter selected for use in CDMA cannot have more than 512 coefficients, so the number of symbols and the oversample ratio should be selected accordingly.

Displaying a Graphical Representation of the Filter

1. Press **More (1 of 2)** > **Display FFT**.

   This displays the filter's frequency response characteristics calculated using a fast Fourier transform.

2. Press **Return** > **Display Impulse Response**.

   This displays the filter's impulse response in time.

3. Press **Return**.

Storing a User-Defined FIR Filter

In this example, you learn how to store a user-defined FIR filter. If you have not created a user-defined FIR filter, complete the steps in the previous sections, "Creating a User-Defined FIR Filter" on page 233.

1. Press **Load/Store** > **Store To File**.

   If there is already a file name from the `Catalog of FIR Files` occupying the active entry area, press the following keys:

   Editing Keys > **Clear Text**

2. Enter a file name (for example, `NEWFIR1`) using the alpha keys and the numeric keypad.

3. Press **Enter**.

The contents of the current FIR table editor are stored to `The Catalog of FIR Files`. This filter can now be used to customize a modulation or as a basis for a new filter design.

Recalling and Applying a User-Defined FIR Filter to a CDMA State

Once the filter is stored in memory, it can be recalled for use with a digital modulation format. This example requires a FIR filter file stored in the `Catalog of FIR Files`. If you have not created and stored a FIR filter file, complete the steps in the previous sections, "Creating a User-Defined FIR Filter" on page 233 and "Storing a User-Defined FIR Filter" on page 235.

This section teaches you how to perform the following tasks:

- "Selecting a User-Defined FIR Filter" on page 236
- "Setting the Oversample Ratio" on page 236
- "Generating the Waveform" on page 236
- "Configuring the RF Output" on page 236

Selecting a User-Defined FIR Filter

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb IS-95A** > **CDMA Define** > **Filter** > **Select** > **User FIR**.

   This opens the `Catalog of FIR Files` from within the IS-95A CDMA digital modulation format.
3. Highlight the FIR file `NEWFIR1`.
4. Press **Select File**.

   The highlighted filter is now selected for use in IS-95A CDMA modulation.

Setting the Oversample Ratio

Press **Return** > **More (1 of 2)** > **Oversample Ratio** > **4** > **Enter**.

Generating the Waveform

Press **Return** > **CDMA Off On**.

This generates the user-defined FIR filtered custom CDMA state created in the previous sections. During waveform generation, the `CDMA` and `I/Q` annunciators activate. The waveform is now modulating the RF carrier.

Configuring the RF Output

1. Press **Frequency** > **890.01** > **MHz**.
2. Press **Amplitude** > **–10** > **dBm**.
3. Press **RF On/Off**.

The custom CDMA waveform with the user-defined FIR filter is now available at the signal generator's RF OUTPUT connector.

Modifying a Default FIR Filter

FIR filters stored in signal generator memory can easily be modified using the FIR table editor. You can load the FIR table editor with coefficient values from user-defined FIR files stored in the signal generator's memory, or from one of the default FIR filters. Then you can modify the values and store the new files. In this example, you load the FIR table editor with the values for a default Gaussian filter and then modify it.

This section teaches you how to perform the following tasks:

- "Loading a Default Gaussian FIR File" on page 237
- "Using Windowing to Modify Default FIR Filters" on page 237
- "Modifying the Coefficients" on page 237

Loading a Default Gaussian FIR File

1. Press **Preset**.
2. Press **Mode** > **CDMA** > **Arb IS-95A**.
3. Press **CDMA Define** > **Filter** > **Define User FIR** > **Oversample Ratio** > **4** > **Enter**.
4. Press **More (1 of 2)** > **Load Default FIR** > **Gaussian**.

Using Windowing to Modify Default FIR Filters

1. Press **Window** > **Hann**.
2. Press **Generate**.

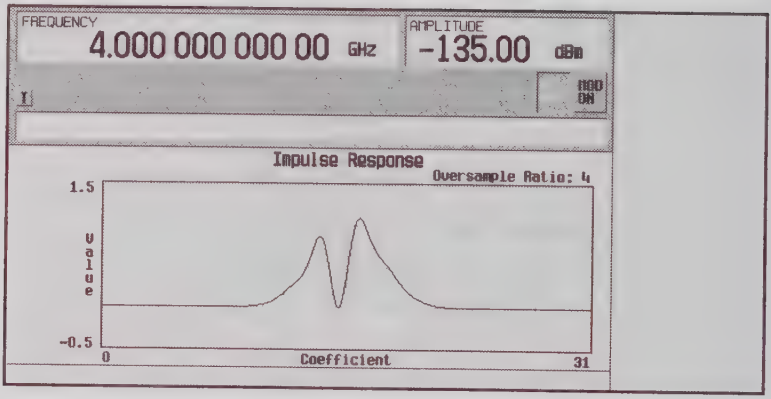
   The FIR table editor now contains the coefficient values for the specified Gaussian filter with Hann windowing.

Modifying the Coefficients

1. Highlight the `Value` item (`1.000000`) for coefficient 15.
2. Press **0** > **Enter**.
3. Press **Display Impulse Response**.

   The effects of the change are displayed, as shown in Figure 7-4 on page 238.

Figure 7-4



The graphic display can provide a useful troubleshooting tool (in this case indicating a missing coefficient value for a proper Gaussian response).

4. Press **Return** > **More (2 of 2)**.
5. Highlight the `Value` item (`0.000000`) for coefficient 15.
6. Press **Edit Item** > **.95** > **Enter**.

For instruction on storing this user-defined FIR filter, see "Storing a User-Defined FIR Filter" on page 235.

Using Differential Encoding

Differential encoding is a digital-encoding technique that denotes a binary value by a signal *change* rather than a particular signal state. It is available for custom real-time I/Q baseband generator waveforms and real-time I/Q baseband generator TDMA waveforms. It is not available for waveforms generated by the dual arbitrary waveform generator.

The signal generator's `Differential State Map` table editor enables you to modify the differential state map associated with user-defined I/Q and user-defined FSK modulations. In this procedure, you create a user-defined I/Q modulation and then configure, activate, and apply differential encoding to the user-defined modulation. For more information, see "Differential Encoding" on page 329.

This section teaches you how to perform the following tasks:

- "Configuring User-Defined I/Q Modulation" on page 239
- "Accessing the Differential State Map Table Editor" on page 240
- "Editing the Differential State Map" on page 241
- "Applying Custom Differential Encoding" on page 242

Configuring User-Defined I/Q Modulation

1. Press **Preset**.
2. Perform the following keypress sequence required for your format type.

   For Custom Format

   Press **Mode** > **Custom** > **Real Time I/Q Base Band** > **Modulation Type** > **Define User I/Q** > **More (1 of 2)** > **Load Default I/Q Map** > **QAM** > **4QAM**

   For TMDA Formats

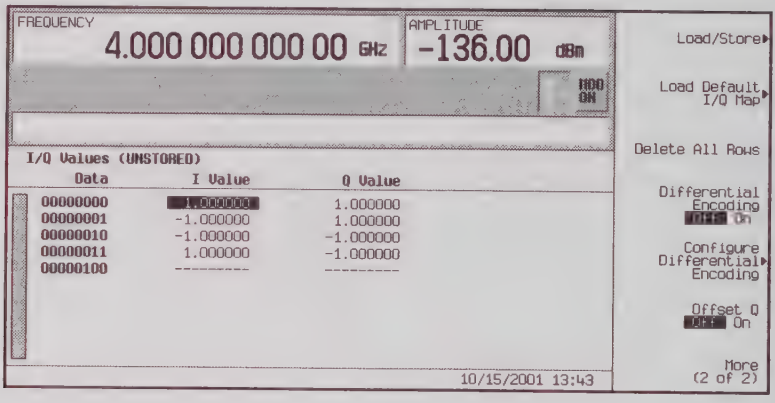
   Press **Mode** > **Real Time TDMA** > ***desired format*** > **More (1 of 2)** > **Modify Standard** > **Modulation Type** > **Define User I/Q** > **More (1 of 2)** > **Load Default I/Q Map** > **QAM** > **4QAM**

This loads a default 4QAM I/Q modulation and displays it in the I/Q table editor.

The default 4QAM I/Q modulation contains data that represent 4 symbols (00, 01, 10, and 11) mapped into the I/Q plane using 2 distinct values (1.000000 and –1.000000). These 4 symbols will be traversed during the modulation process by the symbol table offset values associated

with each symbol of data. Refer to Figure 7-5.

Figure 7-5

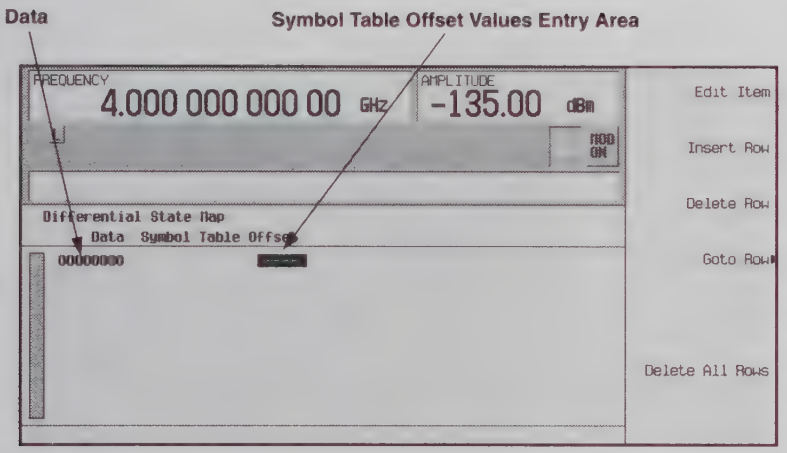


Accessing the Differential State Map Table Editor

Press **Configure Differential Encoding**.

This opens the `Differential State Map` table editor, as shown. At this point, you see the data for the 1st symbol (00000000) and the cursor prepared to accept an offset value.You are now prepared to create a custom differential encoding for the user-defined default 4QAM I/Q modulation. Refer to Figure 7-6 on page 241.

Figure 7-6



Editing the Differential State Map

1. Press **1** > **Enter**.

   This encodes the first symbol by adding a symbol table offset of 1. The symbol rotates *forward* through the state map by 1 value when a data value of 0 is modulated.

2. Press **+/-** > **1** > **Enter**.

   This encodes the second symbol by adding a symbol table offset of –1. The symbol rotates *backward* through the state map by 1 value when a data value of 1 is modulated.

NOTE At this point, the modulation has one bit per symbol. For the first two data values (00000000 and 00000001) only the last bits (the 0 and the 1, respectively) are significant.

---

3. Press **2** > **Enter**.

   This encodes the third symbol by adding a symbol table offset of 2. The symbol rotates *forward* through the state map by 2 values when a data value of 10 is modulated.

4. Press **0** > **Enter**.

   This encodes the fourth symbol by adding a symbol table offset of 0. The symbol does *not* rotate through the state map when a data value of 11 is modulated.

NOTE At this point, the modulation has two bits per symbol. For the data values 00000000, 00000001, 00000010, 00000011, the symbol values are 00, 01, 10, and 11 respectively.

Applying Custom Differential Encoding

Press **Return** > **Differential Encoding Off On**.

This applies the custom differential encoding to a user-defined modulation.

NOTE Notice that `(UNSTORED)` appears next to `Differential State Map` on the signal generator's display. Differential state maps are associated with the user-defined modulation for which they were created.

In order to save a custom differential state map, you must store the user-defined modulation for which it was designed. Otherwise the symbol table offset data is purged when you press the **Confirm Exit From Table Without Saving** softkey when exiting from the I/Q or FSK table editor.

8 Bit Error Rate Testing

Setting Up a PHS Bit Error Rate Test

This section shows how to make BER measurements on a PHS radio using the ESG Signal Generator with Option UN7.

The following procedures explain how to set up the ESG for making BER measurements:

- "Connecting the Test Equipment" on page 245
- "Setting the Carrier Frequency and Power Level" on page 245
- "Selecting the Radio Data Format" on page 246
- "Setting the Radio to a Receiver Mode" on page 246
- "Selecting the BERT Data Pattern and Total Bits" on page 246
- "Selecting the BERT Trigger" on page 247
- "Starting BERT measurements" on page 247

Required Equipment

The following equipment is required to make BER measurements.

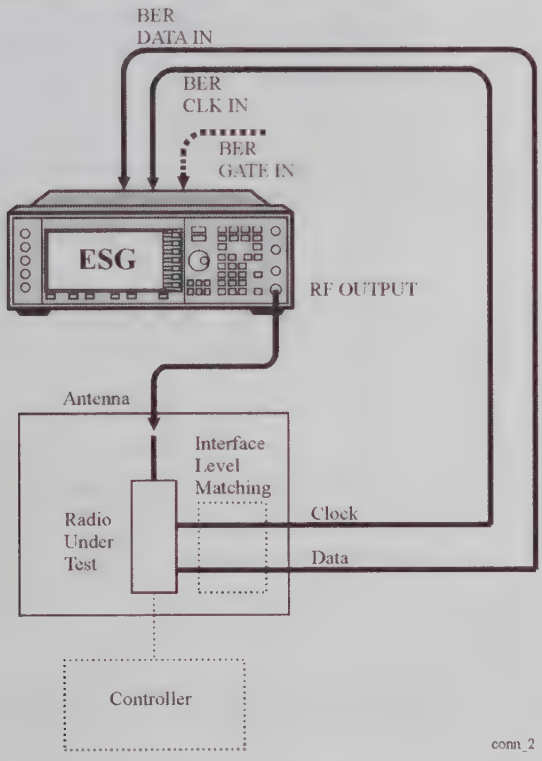
- ESG Signal Generator, model E4438C with Options 001 or 002, 402, and UN7
- an external controller to control the radio under test
- an interface level matching circuit for interfacing between the radio under test and the signal generator when the radio signal specifications are different from those of the signal generator

Connecting the Test Equipment

Refer to Figure 8-1.

1. Connect the cables between your radio and the ESG as follows:

Figure 8-1 Setup for a PHS Bit Error Rate Test



Setting the Carrier Frequency and Power Level

1. Press the **Preset** hardkey.
2. Press the **Frequency** hardkey. Using the numeric keypad, set the signal generator RF output carrier frequency to 1.89515 GHz.
3. Press the **Amplitude** hardkey. Using the numeric keypad, set the signal generator RF output amplitude to –100 dBm.

Selecting the Radio Data Format

1. Press **Mode** > **Real Time TDMA** > **PHS**

   This selects the PHS communications standard.

2. Toggle the **Data Format Pattern Framed** softkey to Framed.

   When you select Framed for bursting the frame envelope, you will be transmitting framed data. This means that you will be bursting the timeslots that you have activated and there will be no RF carrier during the off timeslots.

   Notice that the **Configure Timeslots** softkey has become an active softkey.

   Observe the display and notice that the normal preset condition for downlink timeslot #1 has the timeslot turned on and configured as a traffic channel (TCH).

3. Press **Configure Timeslots**.

   The **Timeslot #** softkey shows that downlink timeslot #1 is selected as the active timeslot. The **Timeslot Off On** softkey shows that downlink timeslot #1 is turned on. The **Timeslot Type** softkey shows that downlink timeslot #1 is configured as a traffic channel.

4. Press **Configure TCH**.

   The **TCH** softkey shows that PN9 is selected as a data pattern.

5. Press **Return** > **Return** > **PHS Off On**.

   At this time the internal baseband generator will generate the internal data patterns that you have configured for Downlink timeslot 1 and Uplink timeslot 1. A message is displayed while this process is taking place. Notice, also, that the `PHS`, `I/Q`, and `ENVLP` display annunciators are turned on.

6. Press **RF On/Off** to toggle RF on.

   Notice that the display annunciator changes from `RF OFF` to `RF ON`. The modulated signal is now available at the RF OUTPUT connector.

Setting the Radio to a Receiver Mode

Set the PHS radio to receive the signal of the specified carrier frequency and the timeslot 1, and output the data used for the bit error rate measurements.

Selecting the BERT Data Pattern and Total Bits

1. Press **Aux Fctn** > **BERT** > **Baseband BERT** > **Configure BERT**.

   Ensure that the **Data** softkey shows PN9 as the selected data pattern. If this is not the case,

press **Data** > **PN9**.

2. Press **Total Bits** > **100000** > **Bits**.

Selecting the BERT Trigger

1. Press **Return** > **Configure Trigger**.

   Notice that the Trigger Key is active in the **BERT Trigger** softkey as the default setting.

2. Press **Return** > **BERT Off On**.

Starting BERT measurements

Press the front panel **Trigger** hardkey to start the BER measurement. You will see the measurement result values of the Total Bits, Error Bits, and BER on the signal generator display.

NOTE If you encounter problems making a BER measurement, check the following:

- Make sure that the cable connections are properly configured.
- Make sure that the data pattern for the BER measurement, specified by the **Data** softkey, matches the data pattern in the traffic channel (TCH) for the RF signal being input to the radio under test.
- Make sure that the RF is turned on.
- Make sure that the amplitude is set to the correct level.
- Make sure that the radio under test is controlled to receive the signal of the specified carrier frequency and the timeslot.

Setting Up a GPS Bit Error Rate Test

This section shows how to make GPS BER measurements using the ESG Signal Generator with Option UN7.

The following procedures explain how to set up the ESG for making BER measurements:

- "Connecting the Test Equipment" on page 249
- "Setting the Carrier Frequency and Power Level" on page 249
- "Selecting the Data Format" on page 250
- "Setting Up the GPS Receiver" on page 250
- "Selecting the BERT Data Pattern and Total Bits" on page 250
- "Selecting the BERT Trigger" on page 250
- "Starting BERT measurements" on page 251

Required Equipment

The following equipment is required to make BER measurements.

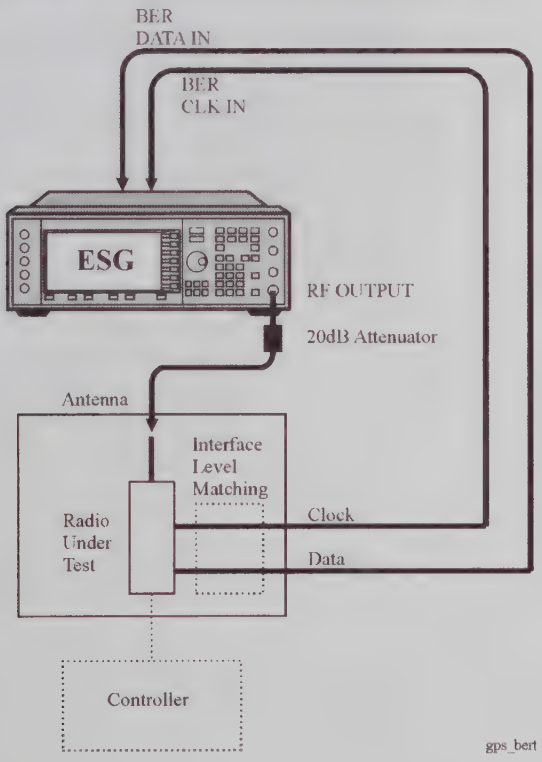
- ESG Signal Generator, model E4438C with Options 001 or 002, 409, and UN7
- an external controller to control the receiver under test
- 20dB attenuator
- an interface level matching circuit for interfacing between the receiver under test and the signal generator when the receiver signal specifications are different from those of the signal generator

Connecting the Test Equipment

Refer to Figure 8-2.

1. Connect the cables between your receiver and the ESG as follows:

Figure 8-2 Setup for a GPS Bit Error Rate Test



Setting the Carrier Frequency and Power Level

1. Press the **Preset** hardkey.
2. Press the **Frequency** hardkey. Using the numeric keypad, set the signal generator RF output carrier frequency to 1.57542 GHz.
3. Press the **Amplitude** hardkey. Using the numeric keypad, set the signal generator RF output amplitude to –135 dBm.

Selecting the Data Format

1. Press **Mode** > **More (1 or 2)** > **Real Time GPS.**
2. Ensure that Raw is the selected data mode.

   If Raw is not the current data mode, press **Data Mode Raw Enc TLM** to Raw.
3. Ensure that PN9 is the selected data sequence.

   If PN9 is not the current data sequence, press **Data** > **PN Sequence** > **PN9.**
4. Press **Real-time GPS Off On** to On.
5. Press **RF On/Off** to toggle the RF output on.

The modulated signal is now available at the RF OUTPUT connector. Notice that the display annunciators for `GPS` and `I/Q` are on and the display annunciator `RF OFF` has changed to `RF ON`.

Setting Up the GPS Receiver

Setup the GPS receiver to accept the carrier frequency and output the data and clock signal used for the bit error rate measurements.

Selecting the BERT Data Pattern and Total Bits

1. Press **Aux Fctn** > **BERT** > **Baseband BERT** > **Configure BERT**.

   If the **Data** softkey does not show that PN9 is the selected data pattern, press **Data** > **PN Sequence** > **PN9.**
2. Press **Total Bits** > **1000** > **Bits**.

   1000 bits at 50 bps per second takes 20 seconds to test.

Selecting the BERT Trigger

1. Press **Return** > **Configure Trigger.**

   If the **BERT Trigger** softkey does not show **Trigger Key** as the selected trigger, press **BERT Trigger** > **Trigger Key**.
2. Press **Return** > **BERT Off On** to On.

Starting BERT measurements

Press the front panel **Trigger** hardkey to start the BER measurement. You will see the measurement result values of the Total Bits, Error Bits, and BER on the signal generator display.

NOTE If you encounter problems making a BER measurement, check the following:

- Make sure that the cable connections are properly configured.
- Make sure that the data pattern for the BER measurement, specified by the **Data** softkey, matches the data pattern of the receiver under test.
- Make sure the data mode selected for the BER measurement is Raw.
- Make sure that the RF is turned on.
- Make sure that the amplitude is set to the correct level.
- Make sure that the receiver under test is controlled to receive the signal of the specified carrier frequency.
- Make sure the chip rate of the external source matches the chip rate set using the **GPS Ref (f0)** softkey.

Measuring RF Loopback BER with Option 300

The following procedure uses the data looped back from the base transceiver station (BTS) to measure the bit error ratio introduced by the BTS receiver when it is receiving coded data from the test equipment. Timing synchronization must first be achieved between the BTS and the test equipment so that data can be transmitted and received at the expected times. Synchronization is achievable either to a received broadcast channel (BCH), to a received full rate speech traffic channel (TCH) in the GSM format, or a packet data channel (PDCH) in the EDGE format.

Required Equipment

The following equipment is required to make loopback BER measurements.

- VSA Series Transmitter Tester, model E4406A, with the following required options:
  - Option BAH - GSM Measurement Personality

NOTE Option 202 replaces Option BAH in the VSA if EDGE support is required.

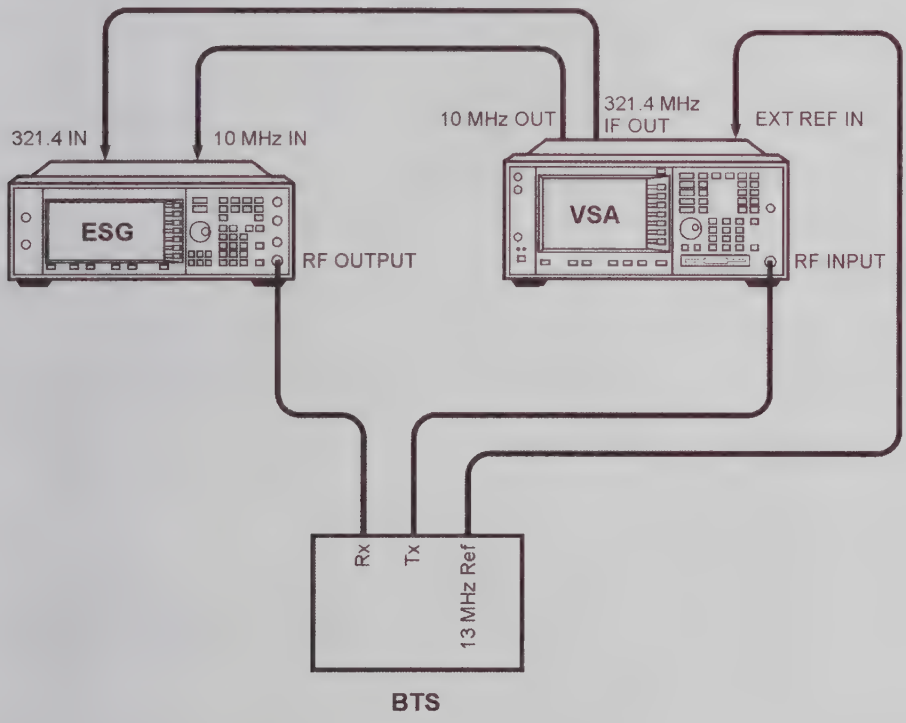
  - Option 300 - 321.4 MHz IF Output
- ESG Vector Signal Generator, model E4438C
  - Option 300 - GSM/EDGE base station loopback BER test capability (requires Options UN7, 001 or 002, 402)

Connecting the Test Equipment

Refer to Figure 8-3 for connections to the ESG, VSA, and base station.

CAUTION If the base station output power is to be greater than the VSA input power specification (+30 dBm), an external attenuator needs to be inserted prior to the RF INPUT connector on the VSA.

Figure 8-3 BTS Loopback Test Equipment Setup



NOTE This example uses an ARFCN of 124 for the BCH and synchronizes to the TCH midamble in timeslot 2 on ARFCN 124. You can substitute as appropriate for your BTS.

All key presses assume factory defined defaults at preset.

Configuring GSM Mode on the Agilent Technologies E4406A VSA Series Transmitter Tester

The following steps will show you how to set up the vector signal analyzer (VSA) for synchronization.

1. To preset the VSA:

   Press **Preset**.

2. To select GSM mode:

   Press **MODE** > **GSM**.

3. To set up GSM mode for BTS test:

   Press **Mode Setup** > **Radio** > **Band** > **P-GSM** > **Return**.

   Toggle **Device BTS MS** until BTS is underlined.

   Toggle **Freq Hopping On Off** until Off is underlined.

4. To set the frequency:

   Press **FREQUENCY Channel** > **ARFCN 124**.

   Center Freq will show `959.800 MHz`.

   Select **Burst Type** > **Normal**.

   Toggle **TSC (Std)** until Auto is underlined.

5. To lock the VSA and ESG to the BTS 13 MHz reference:

   Press **System** > **Reference** > **Freq Ref** > **13** > **MHz**.

   Toggle **Freq Ref Int Ext** until Ext is underlined.

   Toggle **10 MHz Out Off On** until On is underlined.

Configuring GSM Mode on the ESG Vector Signal Generator

The following steps will show you how to configure a timeslot with multiframe data, set up traffic channel 1, and set the frequency and amplitude in GSM mode on the signal generator.

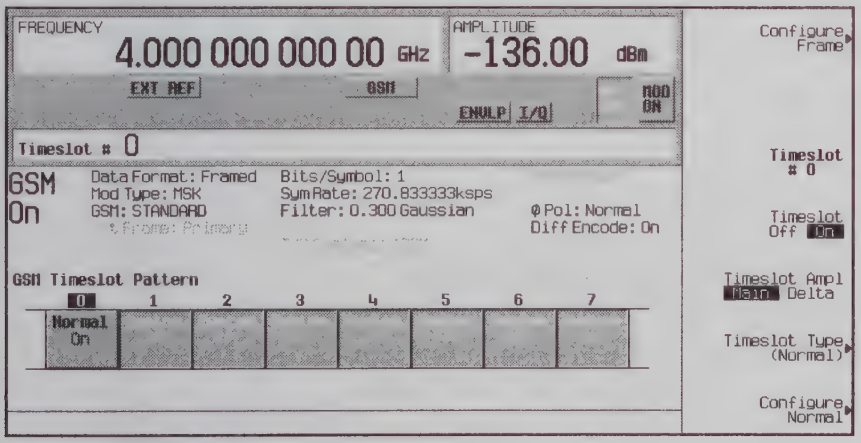
When configuring a timeslot in this procedure, keep the following points in mind:

- Prior to synchronization, the transmitter must be configured to generate multiframe data in the timeslot to be tested.
- TCH synchronization requires that the training sequences match between the ESG timeslot configuration and the timeslot sent by the base station. The default for the ESG, which is TSC0, can be modified.

1. Press **Preset**.
2. Press **Aux Fctn** > **BERT** > **BTS BERT GSM Loopback** > **Configure Measurement** > **Transmit Settings**.
3. Press **GSM On Off** to On > **Data Format Pattern Framed** to Framed > **Configure Timeslots**.

   Refer to Figure 8-4. The GSM timeslot pattern is displayed on the screen.

Figure 8-4



4. Press **Timeslot Off On** to Off.
5. Press **Timeslot #** > **2** > **Enter**.

   Press **Timeslot Type** > **Normal**.

   Press **Configure Normal** > **E** > **Multiframe Channel** > **TCH/FS** > **PN9** (or **PN15**).

NOTE If the default training sequence (TSCO) does not match the training sequence sent by the BTS, press **Return** > **Return** > **TS** and select the proper training sequence.

6. Press **Return** > **Return** > **Return** > **Timeslot Off On** to On.
7. Press **Timeslot #** > **1** > **Enter**.

   Press **Timeslot Type** > **Normal** > **Configure Normal** > **E** > **Multiframe Channel** > **TCH/FS** > **PN9** (or **PN15**).

   Press **Return** > **Return** > **Return** > **Timeslot Ampl Main Delta** to Delta > **Timeslot Off On** to On.

   Repeat these steps for timeslot 3.
8. Press **Amplitude** > **More (1 of 2)** > **Alternate Amplitude** > **Alt Ampl Delta** > **50** > **dB**.
9. To set up traffic channel 124 in GSM mode:

   Press **Frequency** > **More (1 of 2)** > **Freq Channels**.

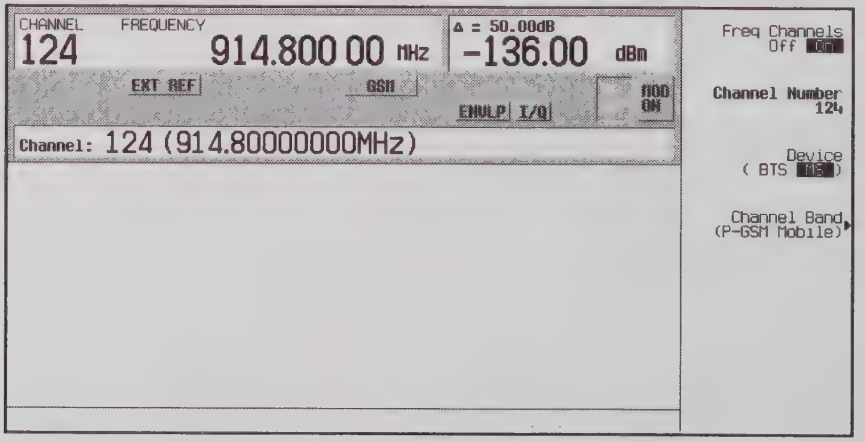
   Press **Device (BTS MS)** to MS > **Channel Band** > **GSM/EDGE Bands** > **P-GSM Mobile**.

   Press **Freq Channels Off On** to On.

   Press **Channel Number** > **124** > **Enter**.

   Refer to Figure 8-5. The active entry area displays the following:
   `Channel: 124 (914.80000000MHz)`

Figure 8-5

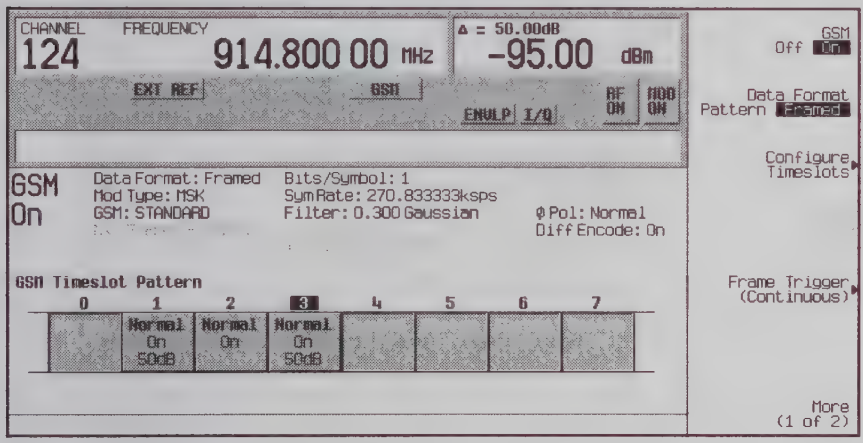


10. Press **Amplitude** > **-95** > **dBm**.

11. Press **Mode Setup** > **RF On/Off**.

    Refer to Figure 8-6. The screen now displays channels 1, 2, and 3 turned on and channels 1 and 3 with a 50 dB alternate amplitude setting. Also, the RF annunciator is turned on, and the new power level is shown in the amplitude area of the display.

Figure 8-6

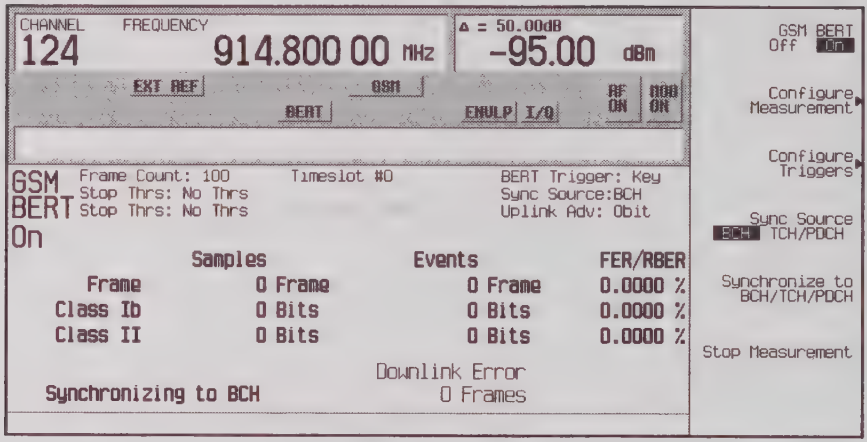


Synchronizing to the BCH Then the TCH

The following steps show you how to synchronize to the broadcast channel (BCH). Set up the base station and start sending the BCH signal now. The BCH is only required to contain the synchronization logical channel (SCH).

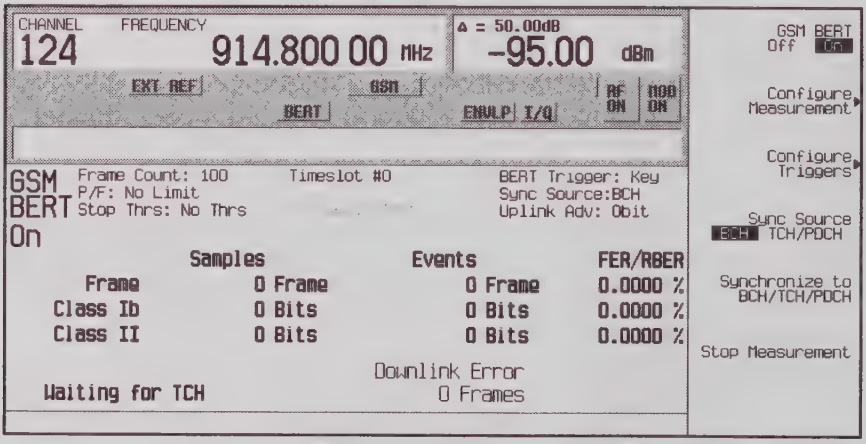
1. Follow the instructions under "Configuring GSM Mode on the Agilent Technologies E4406A VSA Series Transmitter Tester" and "Configuring GSM Mode on the ESG Vector Signal Generator" in this chapter, to prepare the test equipment for synchronization.
2. Press **Aux Fctn** > **BERT** > **BTS BERT GSM Loopback**.
3. Press **Sync Source BCH TCH/PDCH** to BCH.
4. Press **GSM BERT Off On** to On > **Synchronize to BCH/TCH/PDCH**. Refer to Figure 8-7 on page 258. You will briefly see `Synchronizing to BCH` flashing on the display.

Figure 8-7



Once synchronization is achieved, the ESG will expect to receive a TCH to decode and, accordingly, will display the `Waiting for TCH` message. Refer to Figure 8-8.

Figure 8-8



5. Turn off the BCH signal. and set up the base station to send the TCH signal
6. Set up the base station and start sending the TCH signal now. The TCH is only required to contain a valid midamble.

7. On the ESG, press **Configure Measurement** > **Timeslot #** > **2** > **Enter**.

   This sets the ESG to expect the TCH in timeslot 2.

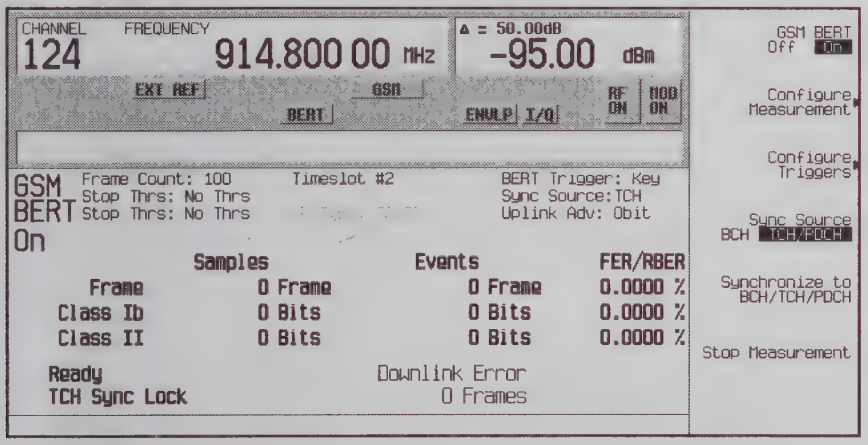
8. Press **Return** > **Synchronize to BCH/TCH/PDCH** to begin synchronization to the TCH.

NOTE For the EDGE format, do the following to achieve `TCH Sync Lock`:
Press **Configure Measurement** > **Timeslot #** > **2** > **Enter** > **Return** > **Adjust Gain**.

Then you will see `Synchronizing to TCH` flashing on the display followed by the `Synchronizing to PN` message.

Once synchronization is achieved, the `Ready TCH Sync Lock` message is displayed. Refer to Figure 8-9.

Figure 8-9



Synchronizing to the TCH

The following steps show you how to synchronize to the traffic channel. The TCH is only required to contain a valid midamble. If appropriate for your base station, this synchronization can be performed without prior BCH synchronization.

NOTE If the base station is transmitting a BCH signal, turn it off at this time.

---

1. Follow the instructions under "Configuring GSM Mode on the Agilent Technologies

E4406A VSA Series Transmitter Tester" and "Configuring GSM Mode on the ESG Vector Signal Generator" in this chapter, to prepare the test equipment for synchronization.

2. Set up the base station and start sending the TCH signal now. The TCH is only required to contain a valid midamble.
3. On the ESG, press **Aux Fctn** > **BERT** > **BTS BERT GSM Loopback**.
4. Press **Sync Source BCH TCH/PDCH** to TCH/PDCH.
5. Press **Configure Measurement** > **Timeslot #** > **2** > **Enter**.

   This sets the ESG to expect the TCH in timeslot 2.
6. Press **Return** > **GSM BERT Off On** to On.

NOTE If the following error message is generated:

```
522 Demodulator Unleveled; Input amplitude underrange
```

this indicates that the TCH signal is not being received.

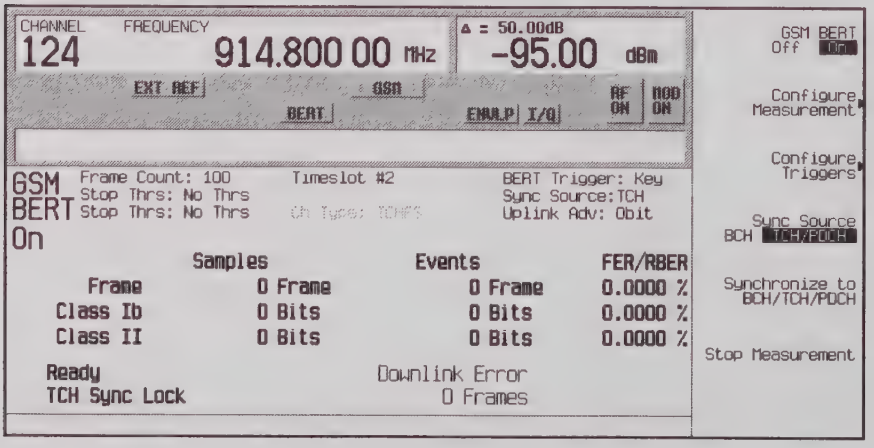
---

7. Press **Synchronize to BCH/TCH/PDCH** to begin synchronization to the TCH.

   Then you will see `Synchronizing to TCH` flashing on the display followed by the `Synchronizing to PN` message.

   Once synchronization is achieved, the `Ready TCH Sync Lock` message is displayed. Refer to Figure 8-10.

Figure 8-10



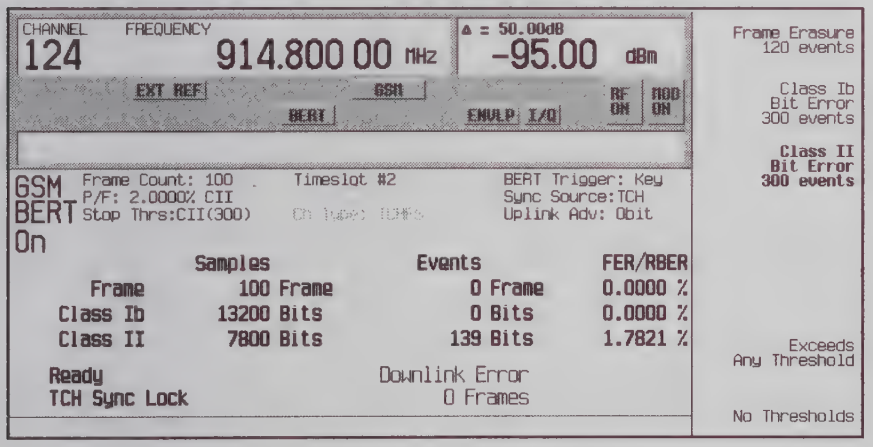
Making Loopback BER Measurements

The following procedure shows you how to configure the frame count, set pass/fail limits and set early stop criteria for loopback BER measurements.

1. Press **Configure Measurement** > **Measurement Mode BER/BLER% Search** to BER/BLER%.
2. Press **BER/BLER% Configure** > **BER% TCH/FS Configure**.
3. Press **Frame Count** > **100** > **Enter**.
4. Press **Pass/Fail Limits** > **Class II RBER** > **2** > **%**.
5. Press **Return** > **Threshold # of Events to Stop** > **Class II Bit Error** > **300** > **Enter**.

   Notice that the **Class II Bit Error** softkey is highlighted, 300 events is displayed beneath the softkey, and `Stop Thrs: CII(300)` appears in the status area of the display.

Figure 8-11



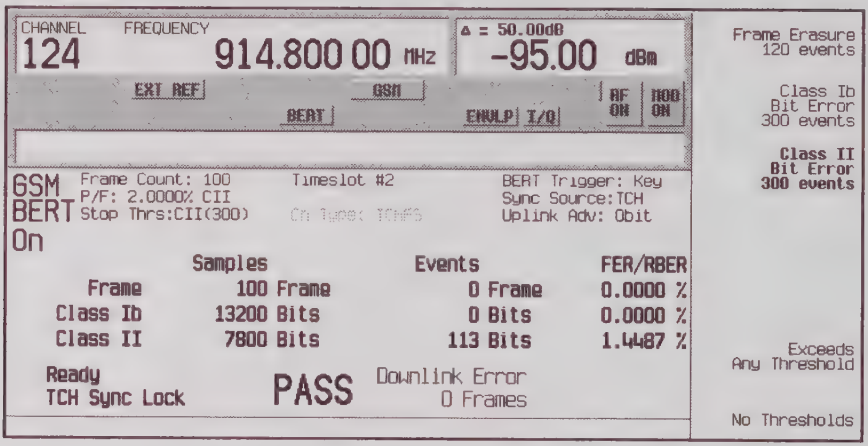
6. Press the **Trigger** hardkey to start the measurement:

   You will see `Pass` or `Fail` displayed on the lower left corner of the screen, when either of the following occurs:

   - The measurement completes normally; in this case, after 100 frames.
   - The measurement terminates early, due to the designated number of events to stop being reached.

Refer to Figure 8-12 on page 262.

Figure 8-12



NOTE To select an alternate trigger mode (for example, Immediate):

Press **Return** three times, then press **Configure Triggers** > **BERT Trigger Source** > **Immediate**.

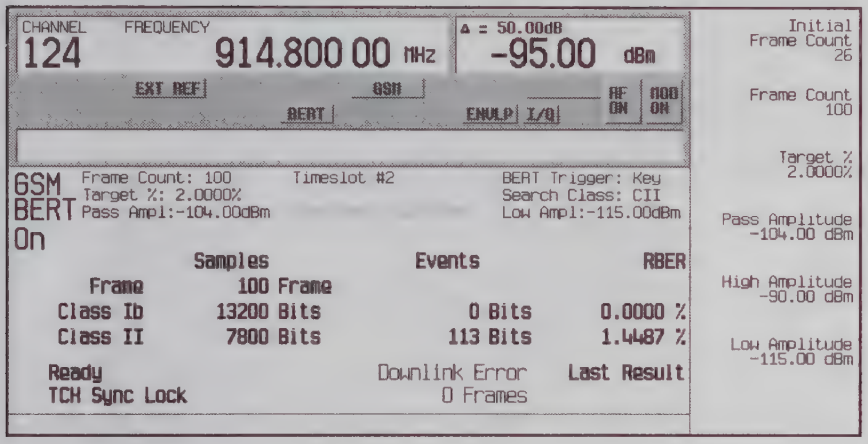
Using Amplitude Sensitivity Search

This procedure shows you how to set a pass amplitude with high and low amplitude boundaries, and how to set both the target error percentage, and the frame count for an amplitude sensitivity search.

1. Press **Aux Fctn** > **BERT** > **BTS BERT GSM Loopback**.
2. Press **Configure Measurement** > **Measurement Mode BER/BLER% Search** to Search.

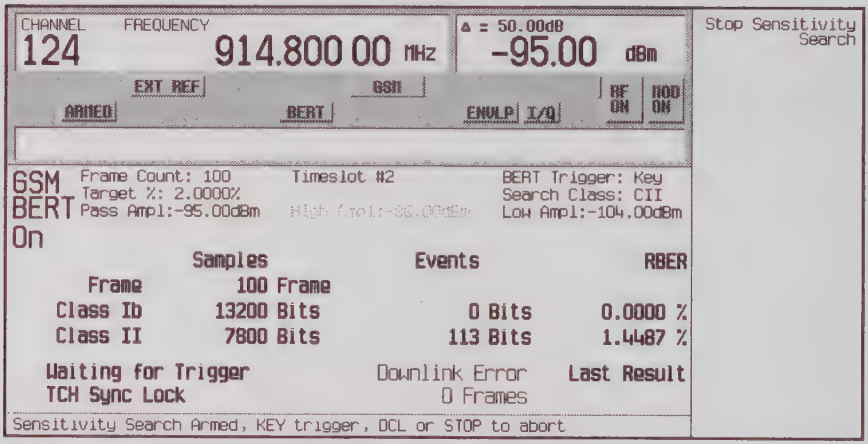
   Notice that the **Configure Sensitivity Search** and **Arm Sensitivity Search** softkeys are enabled.
3. Press **Configure Sensitivity Search** to access the softkey menu for configuring the sensitivity search. Refer to Figure 8-13 on page 263.

Figure 8-13



4. Press **Frame Count** > **100** > **Enter**.
5. Press **Target %** > **2** > **%**.
6. Press **Pass Amplitude** > **–95** > **dBm**.
7. Press **High Amplitude** > **–86** > **dBm**.
8. Press **Low Amplitude** > **–104** > **dBm**.
9. Press **Return** > **Arm Sensitivity Search**. Sensitivity search is now armed, refer to Figure 8-14.

Figure 8-14



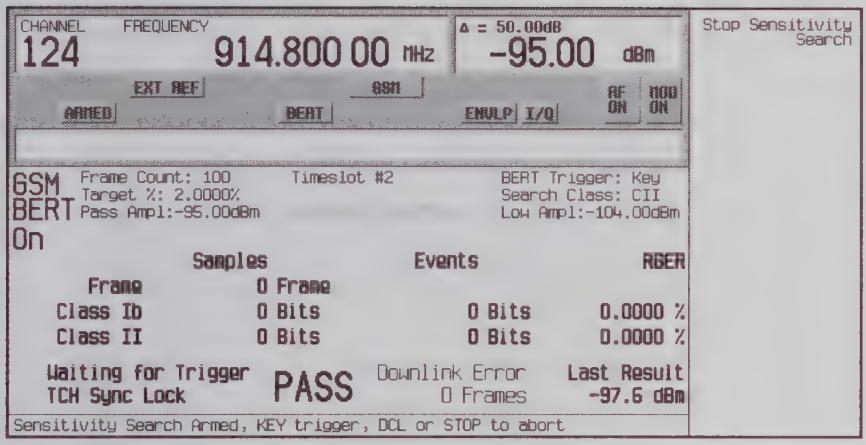
10. Press **Trigger** to start the measurement:

    After the search is complete, `Pass` or `Fail` is displayed on the lower left corner of the screen, when either of the following occurs:

    - The result equals or is less than the target percent within the high to low amplitude range.
    - The high or low amplitude level is passed at the target% BER/RBER.

    Refer to Figure 8-15.

Figure 8-15



11. Press **Stop Sensitivity Search** to terminate a measurement:

NOTE To select an alternate trigger mode (for example, Immediate):
Press **Return** > **Configure Triggers** > **BERT Trigger Source** > **Immediate**.

NOTE For efficiency, the search routine uses shorter measurements initially with the final measurements being over the frame length selected.

Using the External Frame Trigger Function with the EDGE Format

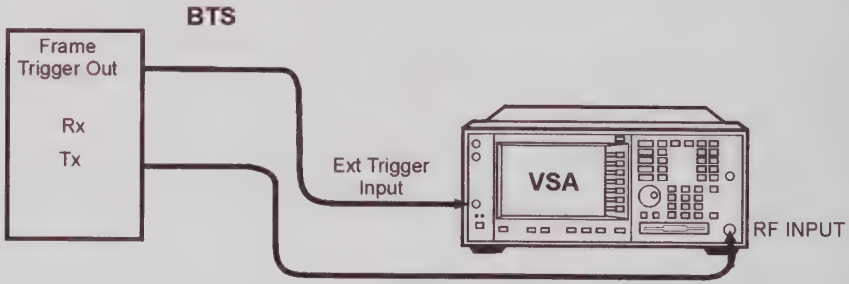
NOTE This function is available only when the **Frame Trigger Source BCH PDCH** is set to PDCH.

The External Frame Trigger Function is used to adjust the burst timing at PDCH synchronization. This requires calculating a delay value and then adjusting the initial value.

Measuring the Initial Delay Value

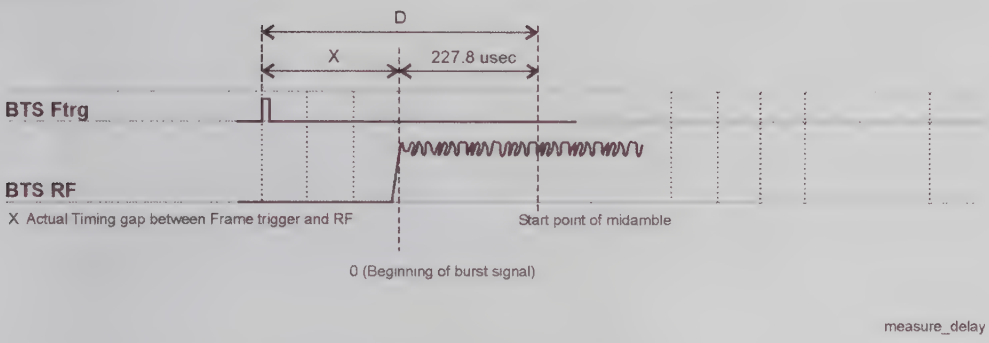
1. Configure the BTS and the VSA setup. Refer to Figure 8-16.

Figure 8-16 System Configuration for Measuring External Delay Value



2. Set up the BTS to transmit the frame trigger EDGE burst at timeslot 0.
3. On the VSA, press **Mode** > **EDGE w/GSM**.
4. Press **Measure** > **Waveform (Time Domain)**.
5. Press **Meas Setup** > **Trig Source** > **Ext Front**.
6. Press **Makers**.
7. Use the marker function to find the offset value (D), in microseconds, between the BTS frame trigger and the starting edge of the midamble. Refer to Figure 8-17 on page 267.

Figure 8-17



8. Calculate the offset value X using the following equation:

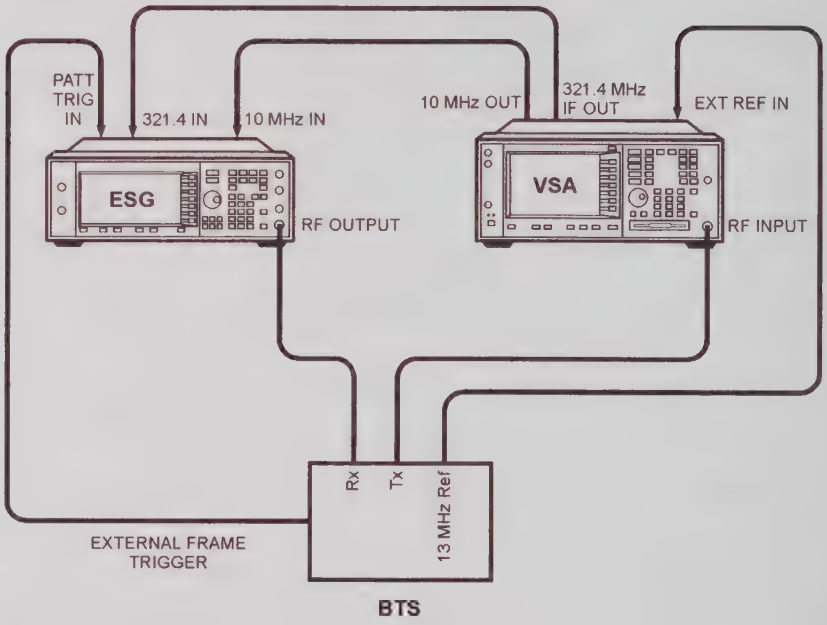
   $X(symbols) = (D - 227.8)/3.693$

   Where, in the EDGE mode, 3.693 µs is equal to 1 symbol.

Adjusting the Delay Value

1. Configure the ESG, BTS, and VSA setup. Refer to Figure 8-18 on page 268.

Figure 8-18



2. Press **Aux Fctn** > **BERT** > **BTS BERT EDGE Loopback**.
3. Press **EDGE BERT** to On > **Configure Triggers**.
4. Press **Frame Trigger Source BCH PDCH** to PDCH.
5. Press **Configure Triggers** > **Frame Trigger Source Int Ext** to Ext.
6. Press Ext Frame Trigger Delay and enter the X value calculated in the previous section.

NOTE If the frame trigger is in the forward direction of timeslot 0, as shown in Figure 8-17 on page 267, enter the X value as a negative value.

---

7. Press **Return** > **Synchronize to BCH/PDCH**.

   Synchronization should occur and display a `Ready` status. However, if `Synchronizing` keeps flashing or the `Ready` status appears for less than a second, increase or decrease the delay value by 2 symbols and press the Synchronize to BCH/PDCH softkey again. Repeat this process until the `Ready` status (synchronization) becomes stable.

8. Press **Configure Triggers** > **Ext Frame Trigger Delay**.
9. Change the delay value by rotating the knob slowly to find the range of delay values that display a Ready status.

NOTE Although the delay value can be entered in 0.25 units, the actual uplink burst position can be changed in 1.0 symbol units.

---

10. If the PDCH is synchronized by a delay value within a ±3 symbol range, choose the center value to set as the frame trigger delay.

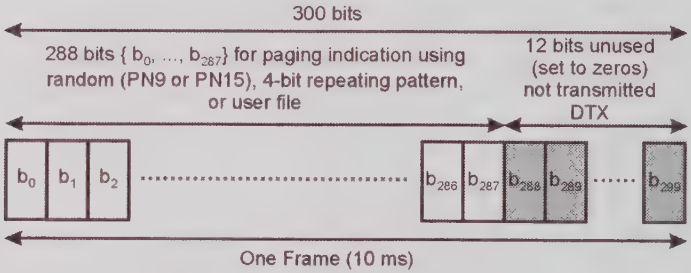
9 Concept Reference

W-CDMA Frame Structures

This section contains graphical representations of W-CDMA frame structures, with associated tables, for both downlink and uplink channels.

Downlink PICH Frame Structure

Figure 9-1 PICH Frame Structure



Symbol rate = 15 ksps

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Downlink PCCPCH + SCH Frame Structure

Figure 9-2 PCCPCH + SCH Frame Structure

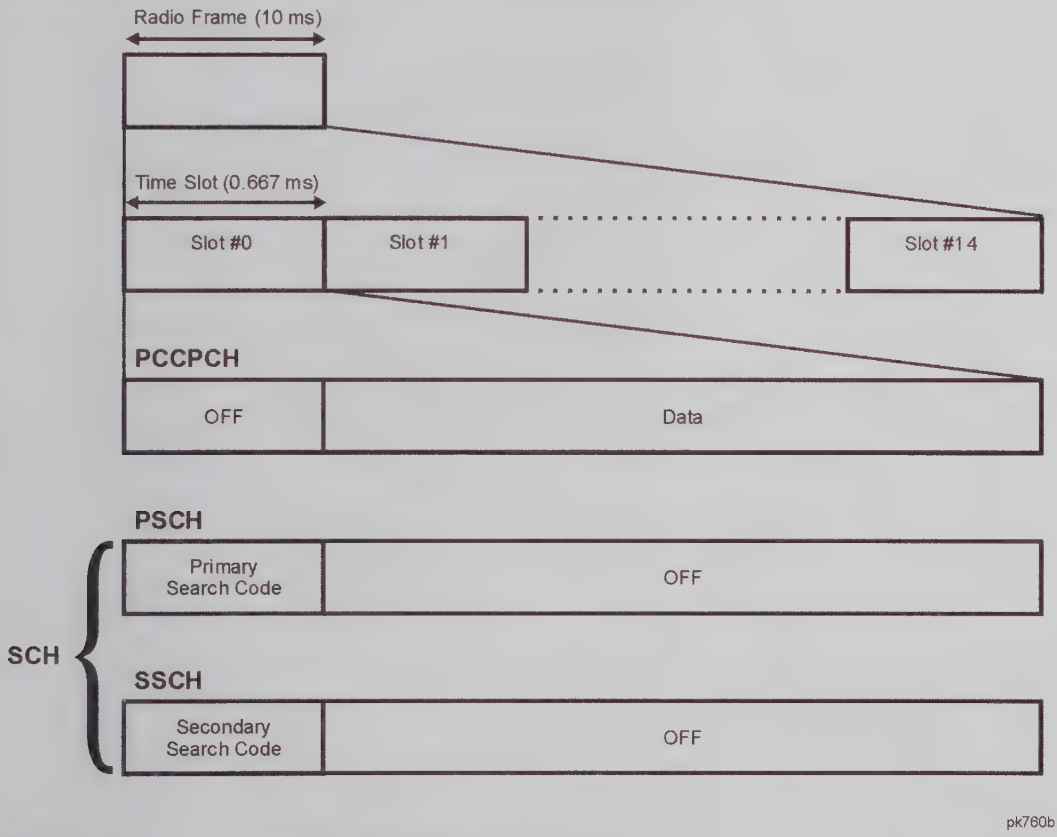

Table 9-1 Lengths of PCCPCH + SCH Fields

Parameter	Symbols Per Slot
N_{data}	9
N_{SCH}[a]	1

a. SCH comprises PSCH and SSCH

Downlink DPCCH/DPDCH Frame Structure

Figure 9-3 DPCCH/DPDCH Frame Structure

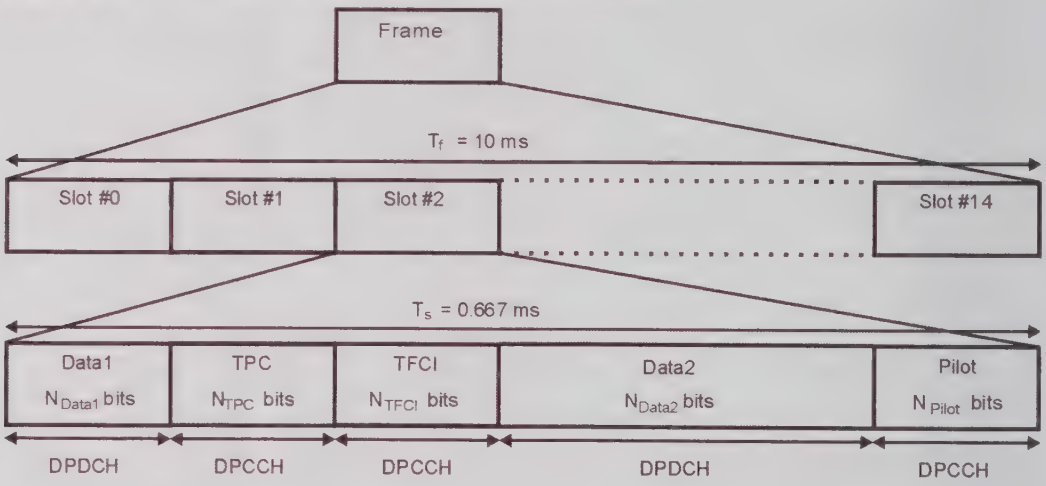

Table 9-2 DPDCH and DPCCH Fields

Channel Bit Rate (Kbps)	Channel Symbol Rate (Ksps)	Spread Factor	Bits/Frame			Bits/Slot	DPDCH Bits/Slot		DPCCH Bits/Slot		
			DPDCH	DPCCH	TOTAL		N_{data1}	N_{data2}	N_{TFCI}	N_{TPC}	N_{pilot}
15	7.5	512		90	150	10	0	4	0	2	4
15	7.5	512	30	120	150	10	0	2	2	2	4
30	15	256	240	60	300	20	2	14	0	2	2[a]
30	15	256	210	90	300	20	2	12	2	2	2[a]
30	15	256	210	90	300	20	2	12	0	2	4[a]
30	15	256	180	120	300	20	2	10	2	2	4[a]
30	15	256	150	150	300	20	2	8	0	2	8[a]
30	15	256	120	180	300	20	2	6	2	2	8[a]

Table 9-2 DPDCH and DPCCH Fields (Continued)

Channel Bit Rate (Kbps)	Channel Symbol Rate (Ksps)	Spread Factor	Bits/Frame				DPDCH Bits/Slot		DPCCH Bits/Slot		
			DPDCH	DPCCH	TOTAL	Bits/Slot	N_{data1}	N_{data2}	N_{TFCI}	N_{TPC}	N_{pilot}
60	30	128	510	90	600	40	6	28	0	2	4[a]
60	30	128	480	120	600	40	6	26	2	2	4[a]
60	30	128	450	150	600	40	6	24	0	2	8[a]
60	30	128	420	180	600	40	6	22	2	2	8[a]
120	60	64	900	300	1200	80	12	48	8[b]	4	8
240	120	32	2100	300	2400	160	28	112	8[b]	4	8
480	240	16	4320	480	4800	320	56	232	8[b]	8	16
960	480	8	9120	480	9600	640	120	488	8[b]	8	16
1920	960	4	18720	480	19200	1280	248	1000	8[b]	8	16

a. The number of pilot bits can vary with channel symbol rates of 15 and 30 ksps.
b. If TFCI bits are not used, then DTX (discontinuous transmission) is used in the TFCI field.

Uplink DPCCH/DPDCH Frame Structure

Figure 9-4 DPCCH/DPDCH Frame Structure

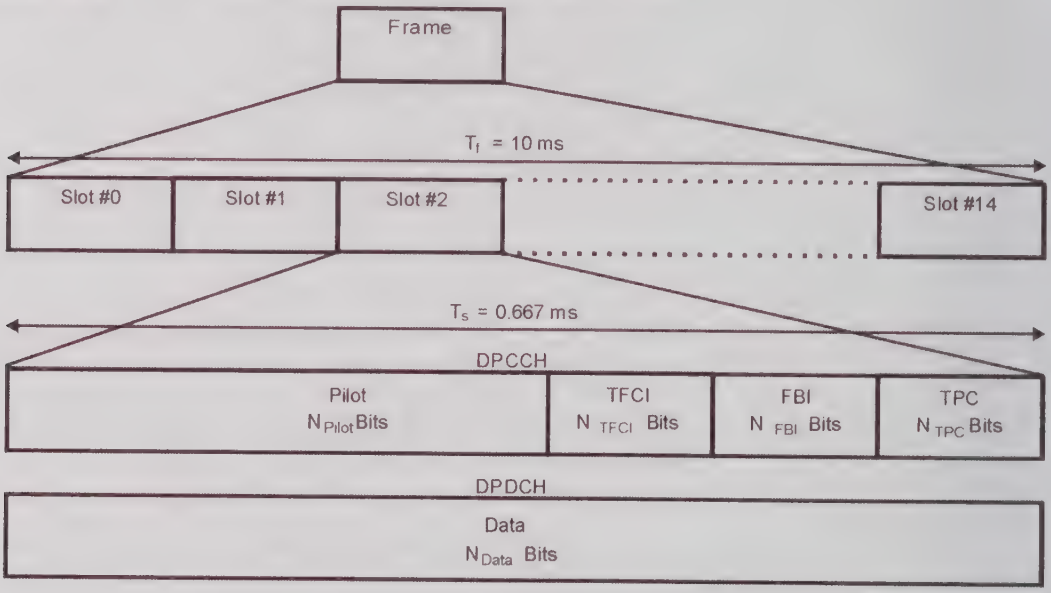

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Table 9-3 DPDCH Fields

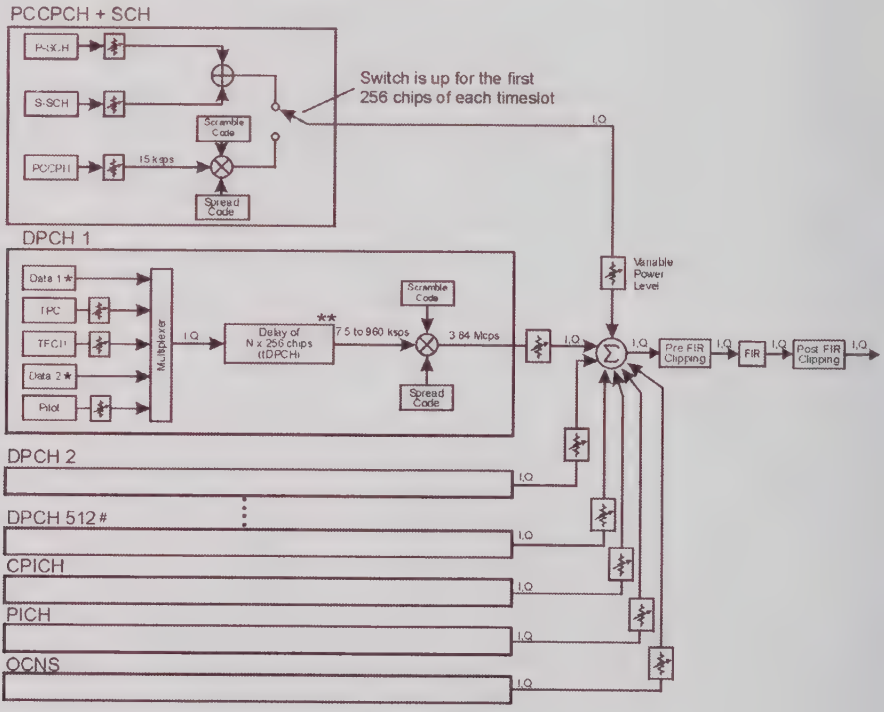
Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	Spread Factor	Bits/Frame	Bits/Slot	N_{data}
15	15	256	150	10	10
30	30	128	300	20	20
60	60	64	600	40	40
120	120	32	1200	80	80
240	240	16	2400	160	160
480	480	8	4800	320	320
960	960	4	9600	640	640

Table 9-4 DPCCH Fields

Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	Spread Factor	Bits/Frame	Bits/Slot	N_{pilot}	N_{TFCI}	N_{FBI}	N_{TPC}
15	15	256	150	10	6	2	0	2
15	15	256	150	10	8	0	0	2
15	15	256	150	10	5	2	1	2
15	15	256	150	10	7	0	1	2
15	15	256	150	10	6	0	2	2
15	15	256	150	10	5	2	2	1

W-CDMA Modulation for Component Test

Figure 9-5 Downlink Channel Structure



Maximum 512 Traffic Channels
** Range of symbol offsets depends on the channel symbol rate.
† Transmission can be configured with or without TFC and variable number of pilot bits.
* Random data, PN9, or 8-bit repeating pattern

Frame structure for DPCH

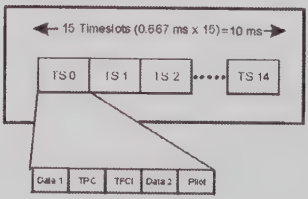
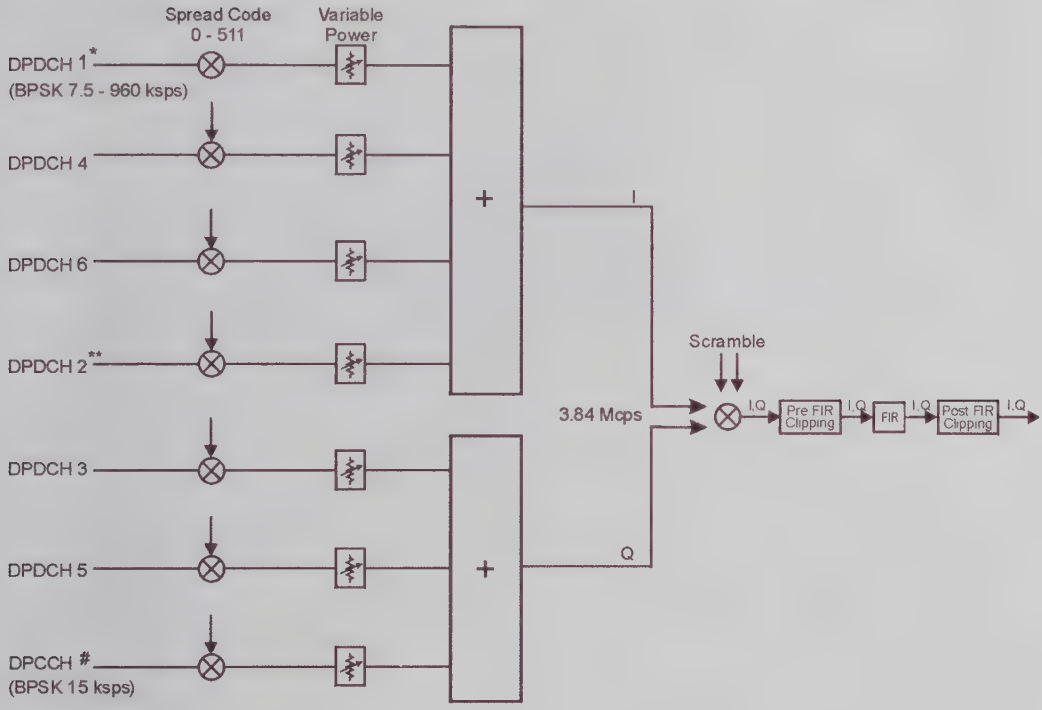
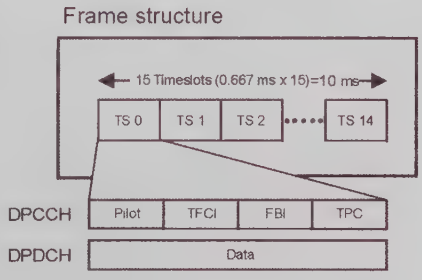


Figure 9-6 Uplink Channel Structure



* User Data: Random, PN9, or 8-bit Repeating Pattern
\# TFC, FBI, & TPC data fields may be edited.
TFCI field may be turned off. Variable number of FBI bits.
** DPDCH 2 can be set to either I or Q. DPDCH 3 - DPDCH 6 alternate between I and Q accordingly.



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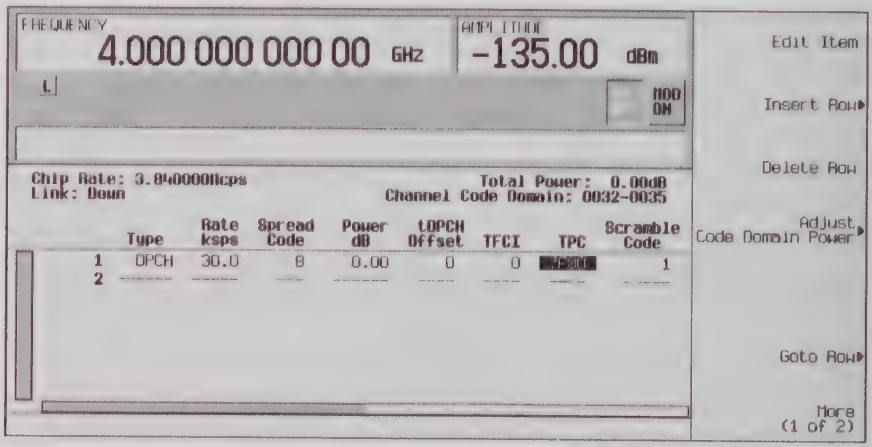
Understanding TPC Values

TPC values determine how the transmit power of the receiving base or mobile station will vary. In the channel table editor, TPC values are represented in hexadecimal format to simplify entries and modifications. Figure 9-7 shows the channel table editor with the TPC value, 7F80, highlighted.

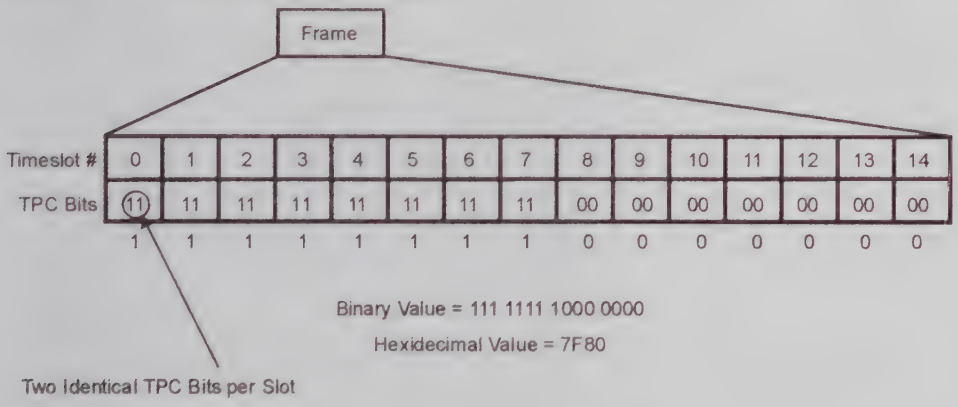
Figure 9-7 Highlighted TPC Value



Hexadecimal TPC values are converted to their binary equivalent. In this example, the value 7F80 becomes 111 1111 1000 0000. Notice that there are 15 digits in the binary TPC value. Because one frame contains 15 timeslots, one binary digit is assigned to each timeslot (see Figure 9-8 on page 281). The assigned bit is then repeated enough times to fill the TPC bit field (see the N_{TPC} column of Table 9-2). Since the example in Figure 9-8 uses two TPC bits per timeslot, the values are either 11 or 00.

The TPC bits that are ones direct the receiving base or mobile station to increase its transmit power by an amount specified by the W-CDMA standard. Likewise, TPC bits that are zeros cause the power to decrease by the same amount. In this example, the transmit power is increasing over timeslots 0 through 7 and decreasing over timeslots 8 through 14.

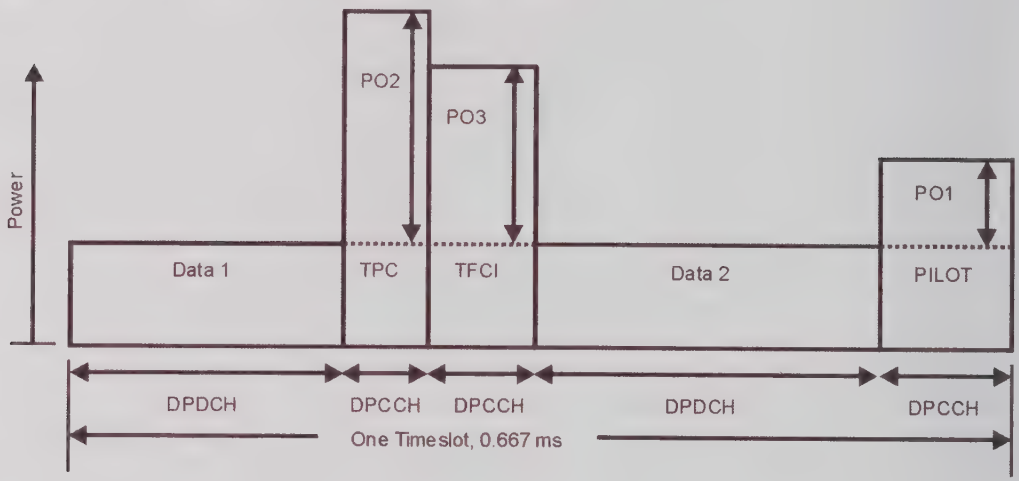
Figure 9-8 TPC Bits per Timeslot



Understanding TFCI, TPC, and Pilot Power Offsets

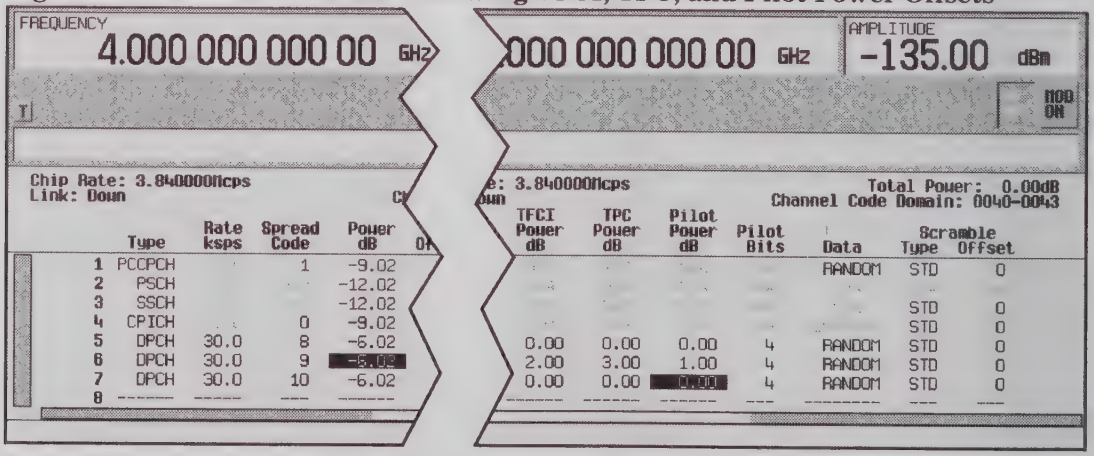
TFCI, TPC, and Pilot power offsets (PO), which are applied to downlink control channels (DPCCH), are relative to the transmit power for data channels (DPDCH). Usually, these offsets are set to a positive value (refer to Figure 9-9 on page 282). The intent is to transmit control symbols at a higher level than data symbols to maintain the link between mobile and base. Because only the DPCCH transmit power is offset, the total transmit power is minimized and less noise is generated in the system.

Figure 9-9 TFCI, TPC, and Pilot Power



The display in Figure 9-10 shows that the channel in row 6 of the table editor has the data transmit power (Power dB) set to –6.02 dB with the following offsets: TFCI Power set to 2.00 dB, TPC Power set to 3.00 dB, and Pilot Power set to 1.00 dB. Because of these offsets, the control symbols corresponding to TFCI, TPC, and Pilot will transmit at –4.02 dB, –3.02 dB, and –5.02 dB respectively.

Figure 9-10 Table Editor Showing TFCI, TPC, and Pilot Power Offsets



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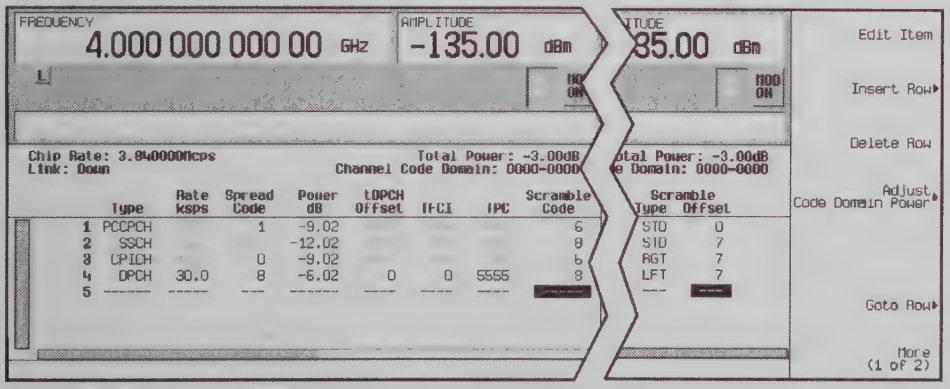
Calculating Downlink Scramble Codes

The Option 400 signal generator implements scrambling codes for downlink channels in compliance with 3GPP specifications. This is done through the use of `Scramble Code`, `Scramble Type`, and `Scramble Offset` fields in the downlink Edit Channel Setup table editor. These fields are linked so that an entry to any field affects the actual scramble code. To better understand the relationship, please refer to the following formula.

$$n = (16 \times i) + k + m$$

Where n = scramble code	Range: 0 to 24575
i = scramble code field input	Primary: Range 0 to 511 Secondary: Range 0 to 511
k = scramble offset field input	Range: 0 to 15
m = scramble type field input	Standard: adds 0 Right Alternate: adds 16384 Left Alternate: adds 8192



The `Scramble Code` field has two sets: primary and secondary, each with a field range of 0 through 511. The primary and secondary sets are determined by the `Scramble Offset` field.

If the `Scramble Offset` field is zero, then the scramble code is in the primary set. Any non-zero entry enables the secondary set. The `Scramble Offset` field has a range of 0 through 15.

The `Scramble Type` field has three modes: Standard, Right Alternate, and Left Alternate. The standard scramble type has a value of zero and does not contribute to the scramble code. Selecting the right alternate adds 16384 to the actual scramble code, whereas the left alternate adds 8192.

Scramble Codes with Standard Scramble Type

A primary scramble code is the product of the `Scramble Code` field entry and 16. Therefore, the primary scramble code set contains all multiples of 16 from 0 through 8176.

A secondary scramble code is the sum of the non-zero `Scramble Offset` field entry and the primary scramble code. The secondary scramble code set uses the numbers in between the multiples of 16.

Thus, all numbers from 0 through 8191 are available for scramble codes when using the standard scramble type.

Refer to the following for examples of scramble codes generated with the primary and secondary sets:

$$n = (16 \times i) + k + m$$

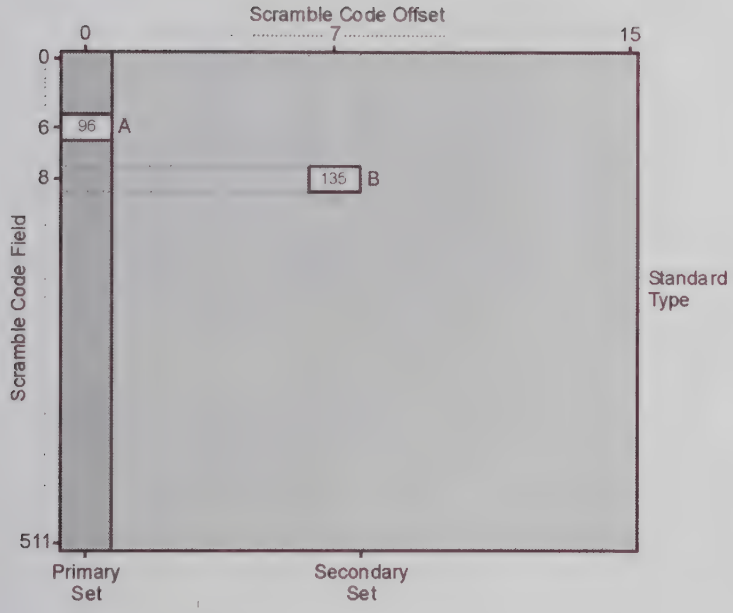
Where n = scramble code

i = scramble code field input

k = scramble offset field input

m = scramble type field input

A: Primary set	**B: Secondary set**
i = 6	i = 8
k = 0	k = 7
m = 0	m = 0
n = 96	n = 135



Scramble Codes with Right and Left Alternate Scramble Types

Recalling that right alternate adds 16384 to the scramble code and left alternate adds 8192, refer to the following examples of scramble codes generated with the right alternate and left alternate scramble types:

$$n = (16 \times i) + k + m$$

Where n = scramble code

i = scramble code field input

k = scramble offset field input

m = scramble type field input

A: Primary set + Left Alternate

i = 6

k = 0

m = 8192

n = 8288

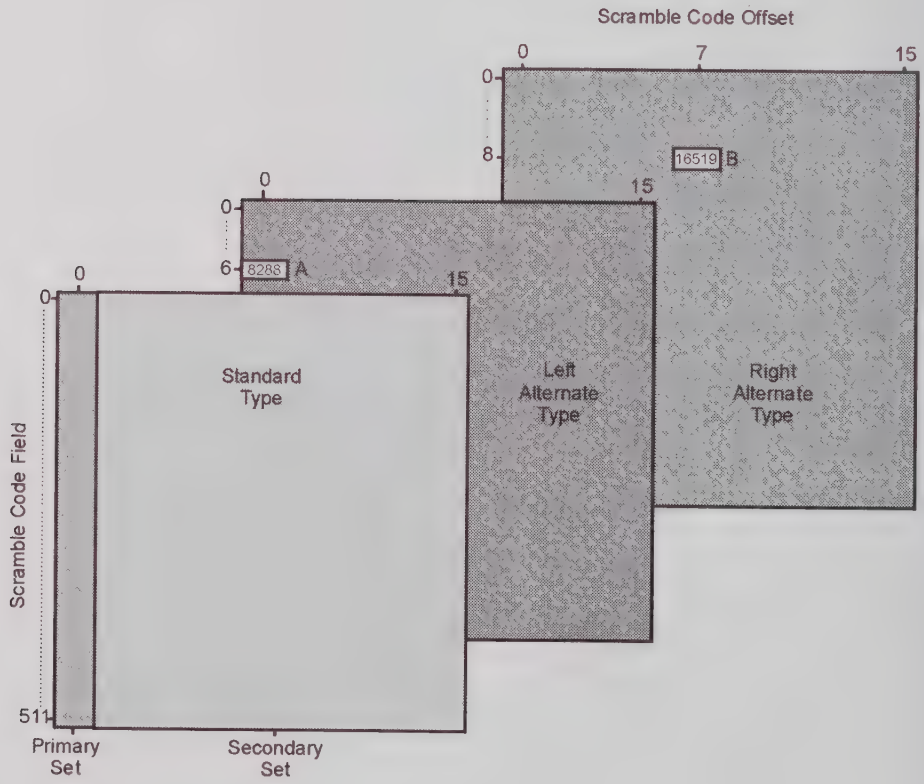
B: Secondary set + Right Alternate

i = 8

k = 7

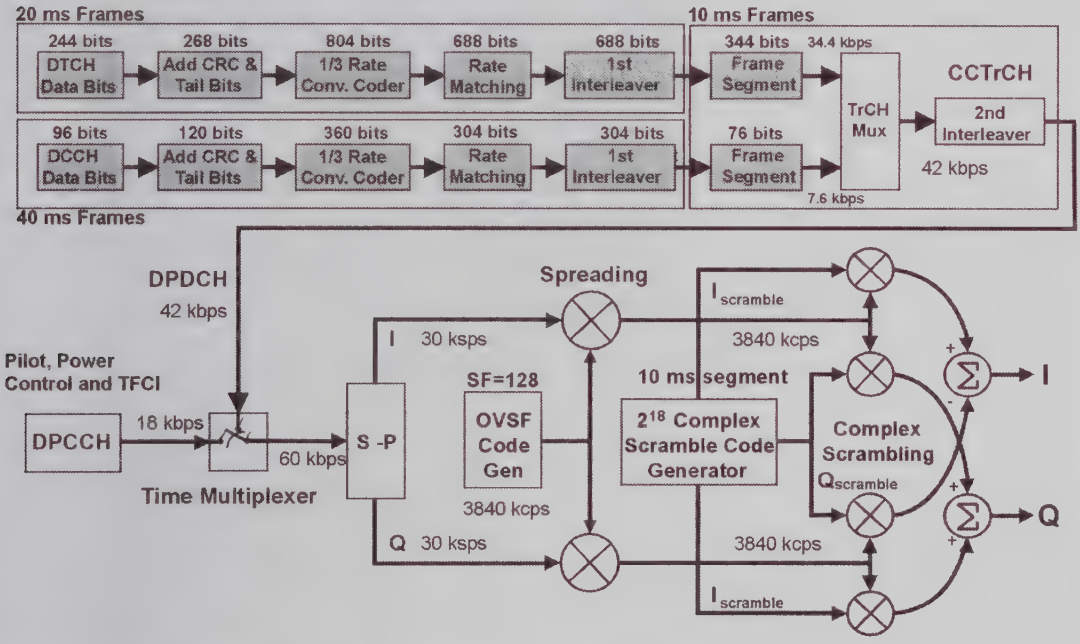
m = 16384

n = 16519



W-CDMA Downlink Modulation for Receiver Test

DPCH Coding Block Diagram



NOTE: Shaded areas of the graphic indicate pre-calculated values based on the user's collection of data and coding parameters. Multiplexing, scrambling and spreading are done real-time.

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Reference Measurement Channels

Real-time I/Q baseband W-CDMA provides reference measurement channels at 12.2, 64, 144, and 384 kilo bits per second (kbps). This personality also provides transport layer channelization for the AMR 12.2 (adaptive multi-rate) protocol.

The signal generator provides one-button setup capabilities for transport channel configuration. The dedicated physical channel DCH (downlink) is predefined by pressing the **Ref Measure Setup** softkey (or sending the appropriate SCPI commands). At least one physical channel needs to be set to DPCH to activate the **Ref Measure Setup** softkey. Also, to activate the **Config Transport** softkey, one of the reference measurement rates must be selected or the DPCH `Data` field value must be set to `Transport CH`.

Table 9-5 describes the downlink reference measurement channel (RMC) configurations generated by pressing the **Ref Measure Setup** softkey after signal generator preset. Transport channel parameters can be modified in a table editor by pressing the **Config Transport** softkey, then moving the cursor to the desired data field and pressing **Edit Item**. DPCH parameters can be individually modified in a table editor by pressing **PhyCH Setup**, then moving the cursor to the desired data field and pressing **Edit Item**.

Table 9-5 The Downlink RMC Predefined DPCH Configuration

Parameter	DPCH Values at Specified Reference Measurement Channel					
	12.2 kbps	64 kbps	144 kbps	384 kbps	AMR 12.2	UDI ISDN
Power	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB
Channel Code[a]	6	6	6	6	6	6
SecSrc Code OS	0	0	0	0	0	0
TPC Pat Steps	1	1	1	1	1	1
Data[b]	Ref 12	Ref 64	Ref 144	Ref 384	AMR 12	ISDN
Symbol Rate[c]	30.00 ksps	120.0 ksps	240.0 ksps	480.0 ksps	30.0 ksps	120.0 ksps
TFCI Pattern	00000000	00000000	00000000	00000000	00000000	00000000
TPC Pattern	Up/Down	Up/Down	Up/Down	Up/Down	Up/Down	Up/Down
Slot Format	11	13	14	15	8	13
Time Offset	0	0	0	0	0	0

a. ESG Channel # 1 default shown. Default channel code for Channels 2 through 4 are based on the equation: Default Channel Code = (Channel #) + 5.
b. If a transport configuration parameter is changed using the **Config Transport** softkey and the table editor, the `Data` field reverts to `Transport CH`, showing that it no longer contains a specified reference measurement channel.
c. Symbol rate is not user-selectable. It is coupled to slot format. To change symbol rate, use the appropriate slot format.

Scramble Codes

The real-time I/Q baseband 3GPP W-CDMA personality implements scrambling codes for downlink OCNS and DPCH channels in compliance with the 3GPP specifications. This is done through the use of the `Scrambling Code` (primary scramble code) field, located in the BS setup menu, and the `SecScr Code OS` (secondary scramble code offset) fields located in the OCNS and DPCH Physical Channel Setup menus. These fields are linked so that an entry to any field affects the actual scramble code. To better understand the relationship, refer to the following formula:

$$n = (16 \times i) + k$$

Where n = scramble code		Range: 0 to 8191
	i = Primary Scrambling Code field input	Range 0 to 511
	k = SecScr Code OS field input	Range: 0 to 15

The primary and secondary sets are determined by the `SecScr Code OS` field values. If the `SecScr Code OS` field value is zero, then the scramble code is in the primary set. Any non-zero entry enables the secondary set. The `SecScr Code OS` field value has a range of 0 through 15.

A primary scramble code is the product of the `Scrambling Code` field value and 16. Therefore, the primary scramble code set contains all the multiples of 16, from 0 through 8176.

A secondary scramble code is the sum of the non-zero `SecScr Code OS` field value and the primary scramble code. The secondary scramble code set uses the numbers in between the multiples of 16.

Thus, all numbers from 0 through 8191 are available for scramble codes.

Refer to the following for examples of scramble codes generated with the primary and secondary sets:

$$n = (16 \times i) + k$$

Where n = scramble code

i = Scrambling Code field input

k = SecScr Code OS field input

A: Primary set

$i = 6$

$k = 0$

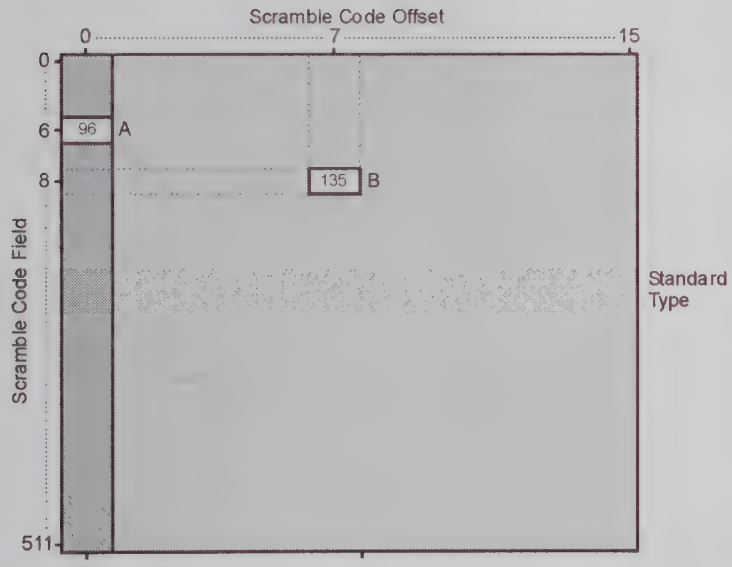
$n = 96$

B: Secondary set

$i = 8$

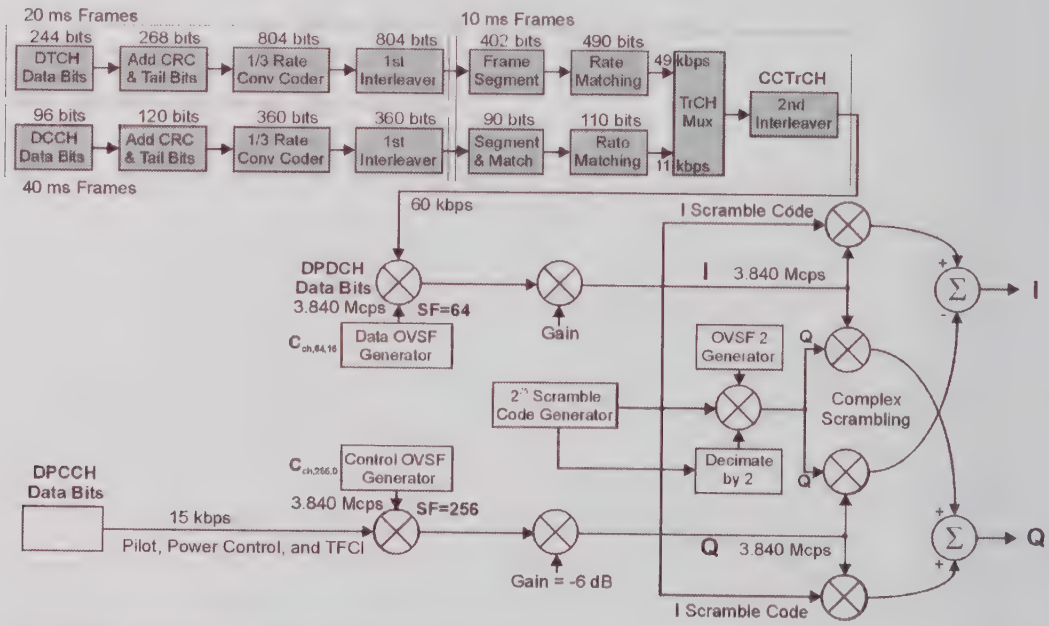
$k = 7$

$n = 135$



W-CDMA Uplink Modulation for Receiver Test

Data Channel Air Interface Block Diagram



NOTE. Shaded areas of the graphic indicate pre-calculated values based on the user's collection of data and coding parameters. Multiplexing and spreading are done real time.

w_ul_air_if

Reference Measurement Channels

3GPP W-CDMA real-time signal generation personality provides reference measurement channels at 12.2, 64, 144, and 384 kbps. This option also provides transport layer coding for AMR 12.2 (adaptive multi-rate) and UDI 64 (unrestricted digital information) protocols.

The signal generator provides one-button setup capabilities for transport channel configuration. The dedicated physical channel DPDCH is predefined by pressing the **Ref Measure Setup** softkey (or sending the appropriate SCPI commands). **DPDCH** and **RMC 12.2 kbps** are the default selections, respectively.

Table 9-6 describes the uplink reference measurement channel (RMC) configurations generated by pressing the **Ref Measure Setup** softkey after signal generator preset. Transport channel parameters can be modified in a table editor by pressing the **Config Transport** softkey, then moving the cursor to the desired data field and pressing **Edit Item**. DPDCH parameters can be individually modified in a table editor by pressing **PhyCH Setup**, then moving the cursor to the desired data field and pressing **Edit Item**.

Table 9-6 The Uplink RMC Predefined DPDCH Configuration

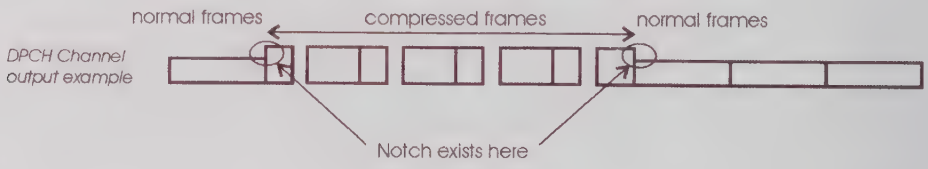
	DPCH Values at Specified Reference Measurement Channel					
Parameter	**12.2 kbps**	**64 kbps**	**144 kbps**	**384 kbps**	**UDI 64 kbps**	**AMR 12.2 kbps**
Power	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB
Beta	15	15	15	15	15	15
Data	TransportCH	TransportCH	TransportCH	TransportCH	TransportCH	TransportCH
Symbol Rate[a]	60.000 ksps	240.000 ksps	480.000 ksps	960.000 ksps	240.000 ksps	60.000 ksps
Slot Format[a]	2	4	5	6	4	2
Channel Code	16	4	2	1	4	16

a. The user-selectable symbol rate and slot format parameters are coupled together.

Transition between Normal Frame and Compressed Frame

In a dedicated physical channel (DPCH), an RF notch exists at the transition between a normal frame and a compressed frame (see Figure 9-11). In a CW signal, the notch measures approximately five microseconds in length and approximately seven decibels in depth (peak compressed mode to peak normal mode).

Figure 9-11 RF Notch with Compressed Mode Transitions

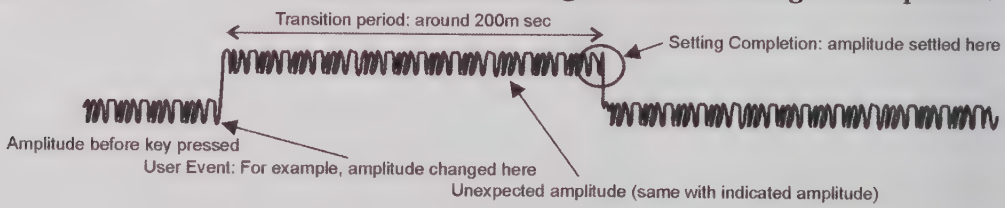


Settling Time during User Event for DPCH Compressed Mode

Some user events, such as changing the amplitude or frequency, will cause the signal to jump to an unexpected amplitude for a short period of time before it settles to expected parameters. This transition period is approximately 200 milliseconds (see Figure 9-12). It is, therefore, important to allow for this time when you make changes to signal characteristics. If you make changes using remote SCPI commands, insert wait instructions into the program. The following events can cause this unstable transition time:

- amplitude and frequency changes
- RF switched on and off
- modulation switched on and off
- ALC switched on and off
- saving or recalling states

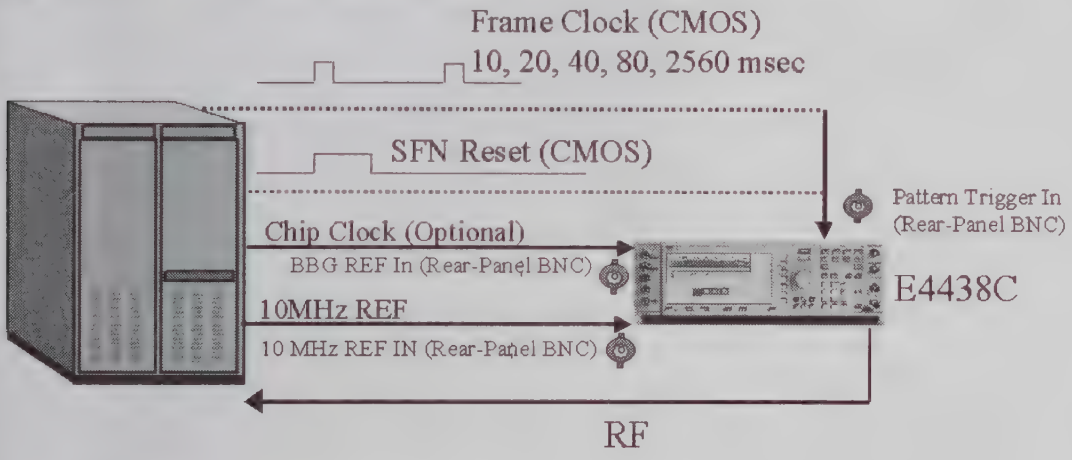
Figure 9-12 DPCH Compressed Mode Signal after a Change in Amplitude


Transition period: around 200m sec
Setting Completion: amplitude settled here
Amplitude before key pressed
User Event: For example, amplitude changed here
Unexpected amplitude (same with indicated amplitude)
amplitude_cmpr

Connecting the ESG to a W-CDMA Base Station

Figure 9-13 shows the connections and signals necessary for the ESG to simulate user equipment when it is connected to a base station.

Figure 9-13 Cable Connections



Trigger Signals (CMOS)
PRACH Trigger: "Burst Gate In" (BNC)
AICH Trigger: "Pattern Trigger IN 2" (AUX Pin 17)
Compressed mode Start Trigger: "Burst Gate In (BNC)
Compressed mode Stop Trigger: "Pattern Trigger IN 2" (AUX Pin 17)

System Triggering and Synchronization

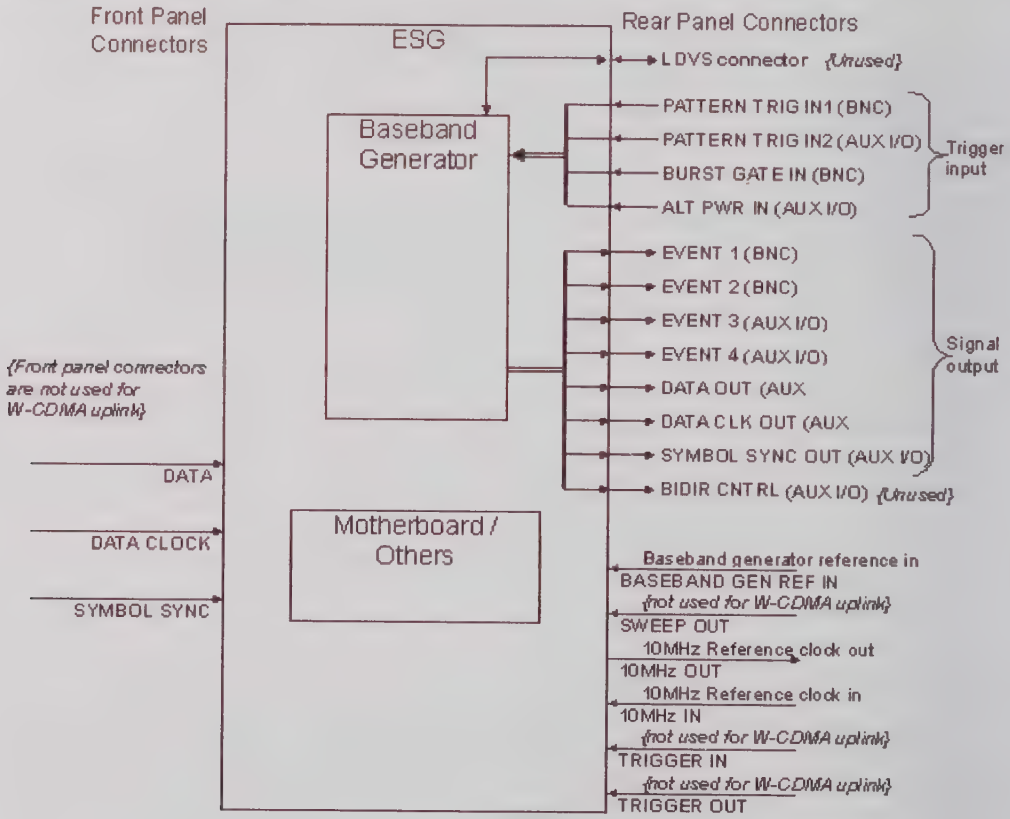
Either the system frame number reset signal or the frame clock which is applied to the PATT TRIG IN connector can be set as a system trigger signal. After a delay time defined by the sum of 1024 chips (T0 = the standard timing offset between downlink and uplink), timing offset, and timeslot offset (plus 10 ms when the SFN reset signal is used), a sync signal is generated to time align all other signals. The RF output signal is generated after the fixed delay of the processing time by the hardware. This delay applies to DPCH mode only. Refer to "Synchronization Diagrams" on page 305 for more information.

For increased measurement accuracy, the signal generator's rear panel 10 MHz OUT frequency reference can be utilized by other instruments in the test system.

Connector Assignments for W-CDMA Uplink

This section describes connector assignments for the W-CDMA uplink personality. The block diagram in Figure 9-14 shows these connector assignments. Notice the front panel connectors are not used in the uplink real-time signal generation personality.

Figure 9-14 ESG I/O Connectors for W-CDMA Uplink



Refer to Table 9-7 for descriptions on connector assignments when using W-CDMA uplink in

DPCH mode. For PRACH mode, refer to Table 9-8 on page 298.

Table 9-7 Connector Descriptions for DPCH Mode

Connector Label	Connector Type	Input/ Output	Assigned Signal
PATTERN TRIGGER IN	BNC	Input	Frame sync trigger. This signal determines the SFN frame timing of the ESG so it is synchronous with the base station.
PATTERN TRIGGER IN 2	AUX I/O Pin 17	Input	Compressed mode stop trigger. Compressed mode must be active. The trigger instructs the signal generator to stop the compressed mode pattern at the frame number specified in the `Stop CFN#` data field.
ALT POWER IN	AUX I/O Pin 16	Input	Trigger for user-defined TPC bits.
BURST GATE IN	BNC	Input	Compressed mode start trigger. Compressed mode must be active. The compressed mode start trigger instructs the signal generator to begin the compressed mode pattern.
BASEBAND GEN REF IN	BNC	Input	External system clock in. This connector is used for chip clock input when using external data clock sources. To use an external signal source as the data clock input, press **BBG Chip Clock Ext Int** to Ext or send the appropriate SCPI command. This clock rate can be multiplied by setting the **Ext Clock Rate X1 X2 X4** softkey to either x2 or x4.
10 MHz IN	BNC	Input	10 MHz reference in.
10 MHz OUT	BNC	Output	10 MHz reference out.
EVENT 1	BNC	Output	Signal assigned by user. Default is DPDCH raw data.

Table 9-7 Connector Descriptions for DPCH Mode

Connector Label	Connector Type	Input/ Output	Assigned Signal
EVENT 2	BNC	Output	Signal assigned by user. Default is DPDCH raw data clock.
EVENT 3	AUX I/O Pin 19	Output	Signal assigned by user. Default is none.
EVENT 4	AUX I/O Pin 18	Output	Signal assigned by user. Default is none.
DATA OUT	AUX I/O Pin 7	Output	Signal assigned by user. Default is DPCCH raw data.
DATA CLOCK OUT	AUX I/O Pin 6	Output	Signal assigned by user. Default is chip clock.
SYMBOL SYNC OUT	AUX I/O Pin 5	Output	Signal assigned by user. Default is sync trigger reply.

Table 9-8 Connector Descriptions for PRACH Mode

Connector Label	Connector Type	Input/ Output	Assigned Signal
PATTERN TRIGGER IN	BNC	Input	Frame sync trigger. This signal determines the SFN frame timing of the ESG so it is synchronous with the base station.
PATTERN TRIGGER IN 2	AUX I/O Pin 17	Input	AICH trigger input. This connector pin is used for the AICH trigger when operating in PRACH mode. The AICH trigger instructs the signal generator to generate the message part. The `Message Part` data field must be set to AICH.
ALT POWER IN	AUX I/O Pin 16	Input	Unused.

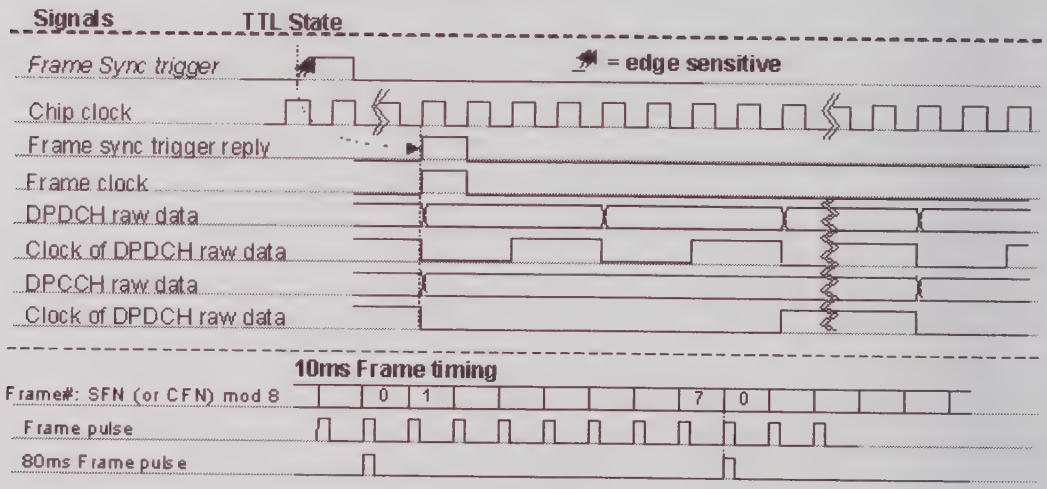
Table 9-8 Connector Descriptions for PRACH Mode

Connector Label	Connector Type	Input/ Output	Assigned Signal
BURST GATE IN	BNC	Input	PRACH start trigger. The connector is used for the PRACH start trigger when PRACH is selected in the physical channel setup. The PRACH start trigger instructs the signal generator to begin the PRACH pattern.
BASEBAND GEN REF IN	BNC	Input	External system clock in. This connector is used for chip clock input when using external data clock sources. To use an external signal source as the data clock input, press **BBG Chip Clock Ext Int** to Ext or send the appropriate SCPI command. This clock rate can be multiplied by setting the **Ext Clock Rate X1 X2 X4** softkey to either x2 or x4.
10 MHz IN	BNC	Input	10 MHz reference in.
10 MHz OUT	BNC	Output	10 MHz reference out.
EVENT 1	BNC	Output	Signal assigned by user. Default is none.
EVENT 2	BNC	Output	Signal assigned by user. Default is none.
EVENT 3	AUX I/O Pin 19	Output	Signal assigned by user. Default is none.
EVENT 4	AUX I/O Pin 18	Output	Signal assigned by user. Default is none.
DATA OUT	AUX I/O Pin 7	Output	Signal assigned by user. Default is none.
DATA CLOCK OUT	AUX I/O Pin 6	Output	Signal assigned by user. Default is none.
SYMBOL SYNC OUT	AUX I/O Pin 5	Output	Signal assigned by user. Default is none.

Signal Descriptions for W-CDMA Uplink

Figure 9-15 shows how W-CDMA uplink input and output signals align with respect to time. Notice that all signals are aligned with the leading edge of the chip clock pulse.

Figure 9-15 Input/Output Signal Alignment



DPCH Mode

Table 9-9 provides descriptions for fixed and user-selectable signals available in DPCH mode. Figure 9-16 on page 302 shows an example of DPCH output timing alignment.

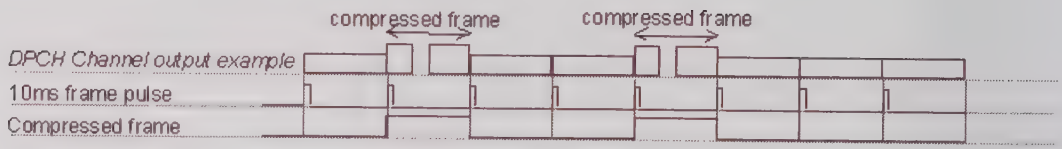
Table 9-9 Signal Descriptions for DPCH Mode

Signal Label	Input/ Output	Signal Description	SCPI Syntax
Frame Sync Trigger	Input	The input signal can be set to either the frame clock or the system frame number SFN) reset signal by toggling the **Sync Source FClk SFN** softkey. The frame clock can be set to 10, 20, 40, 80, or 2560 ms.	FSYN
TPC User File Trigger	Input	Trigger for user-defined TPC bits.	USER

Table 9-9 Signal Descriptions for DPCH Mode

Signal Label	Input/ Output	Signal Description	SCPI Syntax
Compressed Mode Start Trigger	Input	Trigger to start compressed mode.	CSTT
Compressed Mode Stop Trigger	Input	Trigger to stop compressed mode.	CSPT
None	Output	No signal.	RPS0
Chip Clock	Output	Chip clock. 3.84 MHz is the default setting.	RPS1
Trigger Sync Reply (system sync output)	Output	Response pulse of the frame sync trigger. The frame sync trigger reply reports that the frame sync trigger was received, and is used to adjust frame timing. When the system trigger is not received, the system sync output pulse is not generated.	RPS7
DPDCH Raw Data	Output	DPDCH data after 2nd interleaver (before spreading and scrambling).	RPS2
DPCCH Raw Data	Output	DPCCH data after 2nd interleaver (before spreading and scrambling).	RPS4
DPDCH Raw Data Clock	Output	The clock for DPDCH raw data. The rate depends on the slot format (data rate) of DPDCH.	RPS3
DPCCH Raw Data Clock	Output	The clock for DPCCH raw data. The rate of this clock is fixed at 15 kHz.	RPS5
10 ms Frame Pulse	Output	Indicates the frame boundaries for data generation.	RPS6
TTI Frame Pulse	Output	Indicates the frame boundaries for TTI.	RPS9
CFN #0 Frame Pulse	Output	Indicates the frame boundaries for CFN frame #0.	RPS10
Compressed Frame	Output	This signal indicates the status of the compressed frame. A 0 indicates a normal frame. A 1 indicates a compressed frame.	RPS8

Figure 9-16 DPCH Signal Alignment



PRACH Mode

Table 9-10 provides descriptions for fixed and user-selectable signals available in PRACH mode. Figure 9-17 on page 304 shows an example of PRACH output timing alignment.

Table 9-10 Signal Descriptions for PRACH Mode

Signal Label	Input/ Output	Signal Description	SCPI Syntax
Frame Sync Trigger	Input	The input signal can be set to either the frame clock or the system frame number SFN) reset signal by toggling the **Sync Source FClk SFN** softkey. The frame clock can be set to 10, 20, 40, 80, or 2560 ms.	FSYN
PRACH Start Trigger	Input	Trigger to start PRACH.	PSTR
AICH Trigger	Input	Trigger to start AICH.	AITR
None	Output	No signal.	RPS0
Chip Clock	Output	Chip clock. 3.84 MHz is the default setting.	RPS1
Trigger Sync Reply (system sync output)	Output	Response pulse of the frame sync trigger. The frame sync trigger reply indicates how much frame alignment was necessary.	RPS7
Preamble Raw Data	Output	Preamble data after 2nd interleaver (before spreading and scrambling).	RPS15
Preamble Raw Data Clock	Output	The clock for preamble raw data.	RPS16

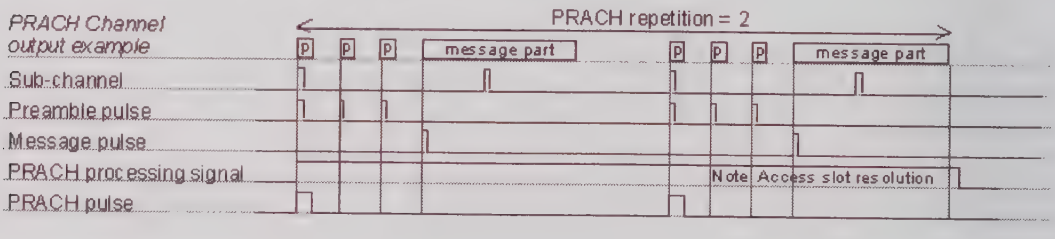
Table 9-10 Signal Descriptions for PRACH Mode

Signal Label	Input/ Output	Signal Description	SCPI Syntax
Message Data Raw Data	Output	The data for the message data part after 2nd interleaver (before spreading and scrambling).	RPS11
Message Ctrl Raw Data	Output	The data for the message control part after 2nd interleaver (before spreading and scrambling).	RPS13
Message Data Raw Data Clock	Output	The clock for the message data part raw data.	RPS12
Message Ctrl Raw Data Clock	Output	The clock for the message control part raw data.	RPS14
PRACH Processing	Output	This signal indicates the status of PRACH signaling. The signal is high until the configured number of PRACH repetitions is complete. A 0 indicates the PRACH signal is off. A 1 indicates the PRACH signal is generating. The signal's state changes in accordance with access slot resolution.	RPS19
Sub-Channel Timing	Output	Indicates sub-channel timing, which is specified through the user interface. A PRACH data stream must begin on the leading edge of one of these pulses.	RPS17
10 ms Frame Pulse	Output	Indicates the frame boundaries for SFN.	RPS6
80 ms Frame Pulse	Output	Indicates the frame boundaries for SFN mod 8=0.	RPS20
Preamble Pulse	Output	Indicates the start for each preamble access slot.	RPS21
Message Pulse	Output	Indicates the start of an access slot when the message part is going to be transmitted.	RPS22

Table 9-10 Signal Descriptions for PRACH Mode

Signal Label	Input/ Output	Signal Description	SCPI Syntax
PRACH Pulse	Output	Indicates the beginning access slot boundary of a PRACH repetition (preamble only or preamble+message).	RPS23

Figure 9-17 PRACH Signal Alignment

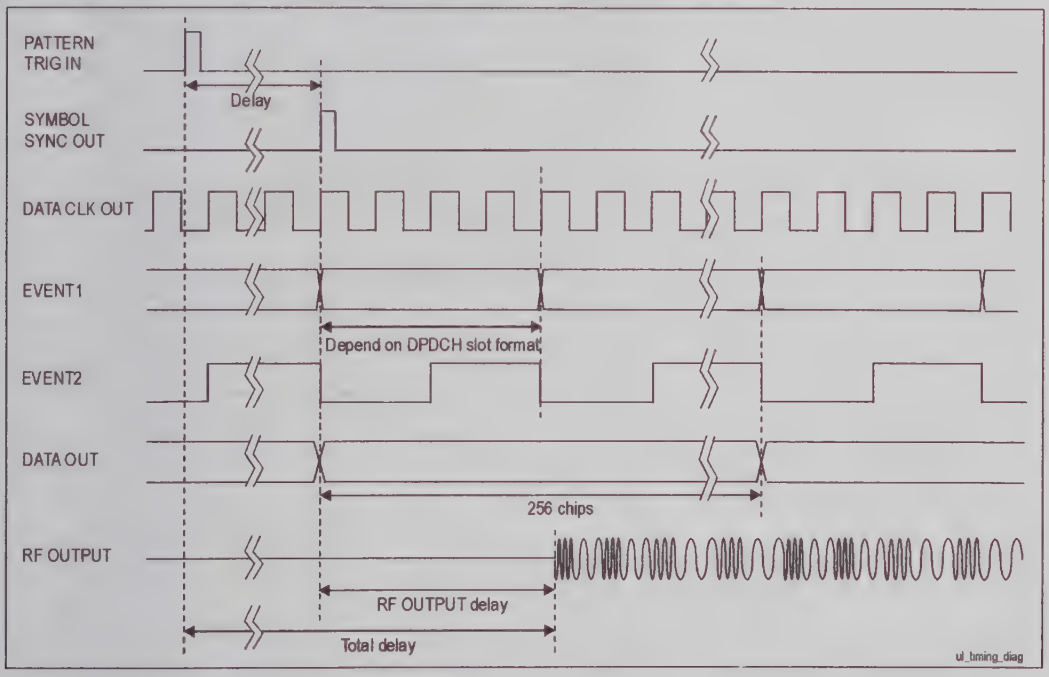


Synchronization Diagrams

Signal Alignment for Default DPCH Mode

Figure 9-18 illustrates the timing relationships between the signals from the rear panel BNC input and output connectors relative to the RF Output connector for default signal assignments in DPCH mode. Signal states are referenced to the chip clock provided at the DATA CLK OUT connector.

Figure 9-18 Signal Alignment for Default DPCH Mode



DPCH Synchronization

Figure 9-19 illustrates the timing alignment for the DPCH channel. Delay time is defined by the sum of T0 (1024 chips = the standard timing offset between downlink and uplink), timing offset, and timeslot offset.

Figure 9-19 DPCH Synchronization - Frame Timing Alignment

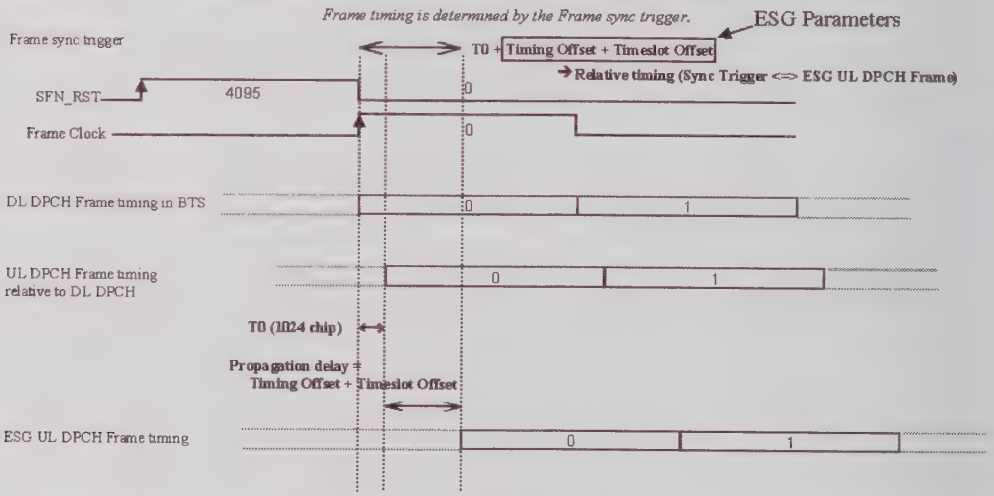


Figure 9-20 illustrates the frame number alignment for the DPCH channel. The frame number is aligned by the frame sync trigger signal from the BTS. When using the frame clock, set the frame clock period to be equal or greater than the longest transport channel TTI period (select 10, 20, 40, or 80 ms). In Figure 9-20, Reference Measurement Channel 12.2k requires a frame clock of 20 ms or longer to achieve the correct frame number alignment. Using a frame clock of 10 ms would cause an unpredictable frame timing alignment with the transport channel TTI period. Best results are achieved when the frame clock is set to 80 or 2560 ms, or a system frame number reset signal is used. (The signal generator's TTI period can be measured on the TTI frame pulse from the rear panel.)

Figure 9-20 DPCH Synchronization - Frame Number Alignment

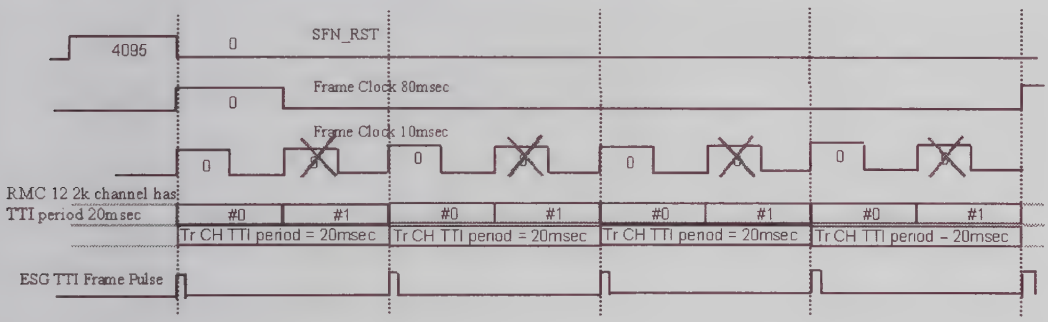
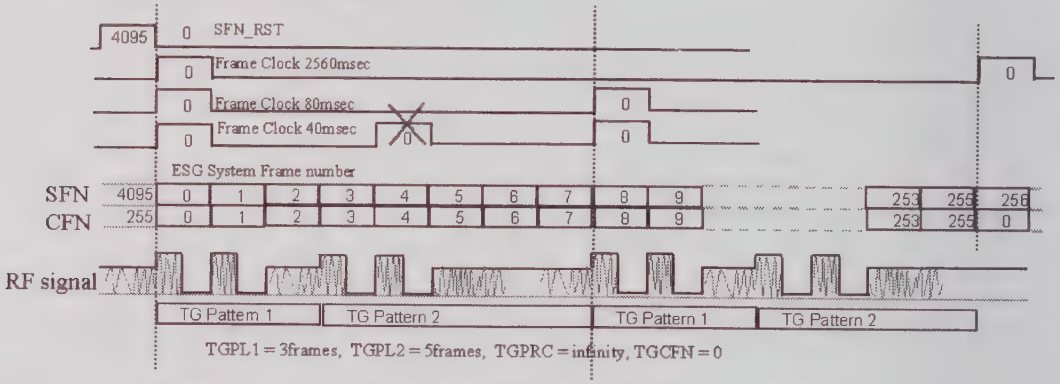


Figure 9-21 illustrates the frame number alignment for compressed mode when the TGPRC data field is set to Infinity. In this case, the frame clock period must be equal to or be a multiple of the compressed mode (TG pattern length) definition.

Figure 9-21 DPCH Synchronization - Frame Number Alignment for Continuous (Infinity) Compressed Mode

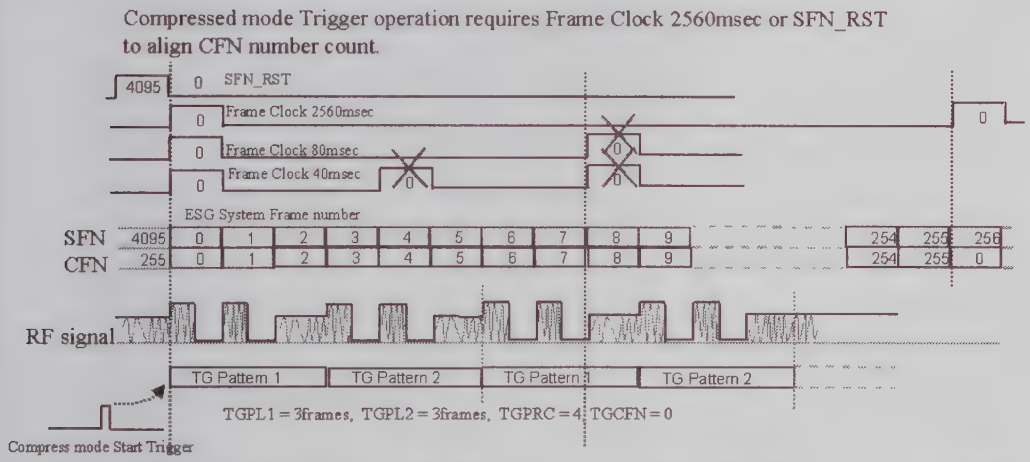
Frame Clock period must match with or multiple of Compressed mode (TG Pattern length) definition when TGPRC is set as Infinity.



Example 1, TG pattern can be aligned with Frame Clock 80msec, but not with 40msec

Figure 9-22 illustrates the frame number alignment for compressed mode when it is required to align with CFN number counting. This mode of operation requires a frame clock of 2560 ms or a system frame number reset signal as the frame sync trigger.

Figure 9-22 DPCH Synchronization - Frame Number Alignment for Compressed Mode with CFN Number Count



Example 2, Transmission Gap (compress) pattern can be aligned with SFN_RST or Frame Clock 2560msec, However, NOT with 80msec

PRACH Synchronization

Figure 9-23 illustrates the frame timing alignment for the PRACH channel. Delay time is defined by the sum of the timing offset and timeslot offset minus the Tp-a value.

Figure 9-23 PRACH Synchronization - Frame Timing Alignment

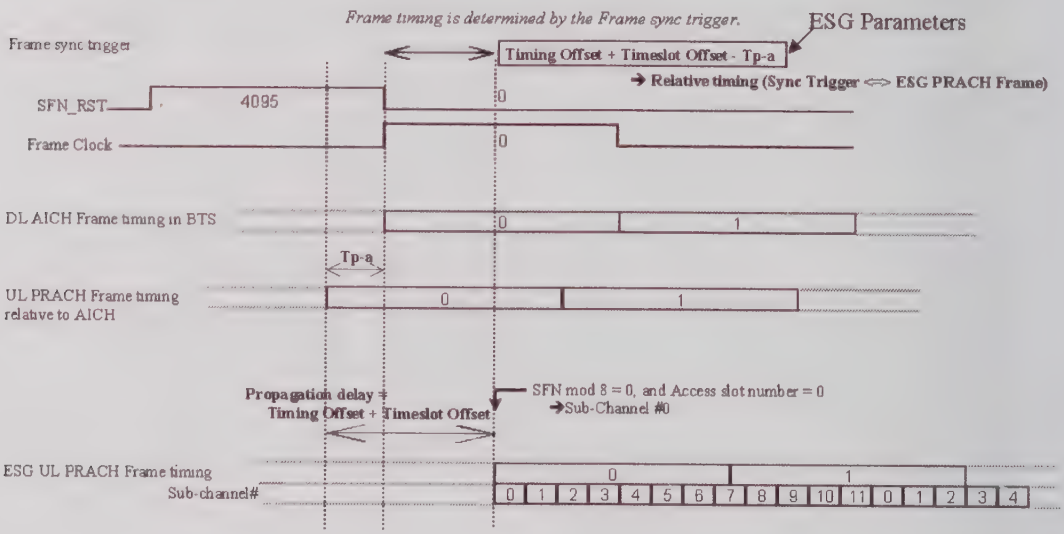
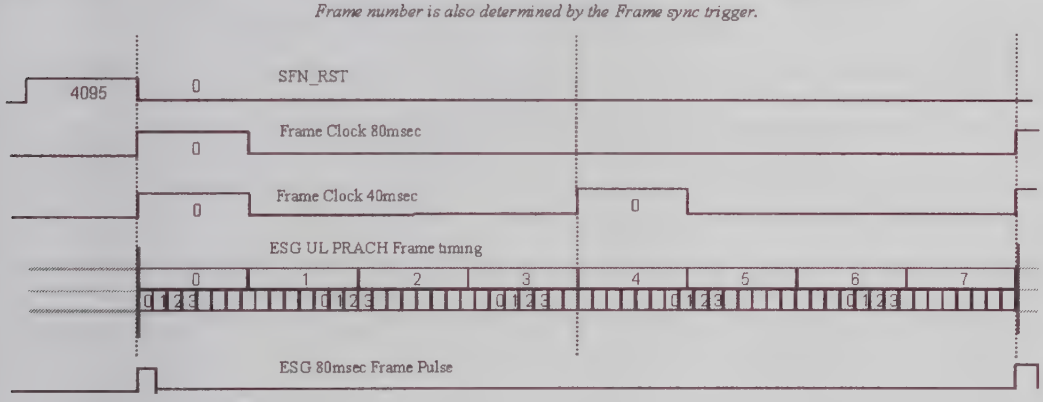


Figure 9-24 illustrates the frame number alignment for the PRACH channel. The frame number is aligned by the frame sync trigger signal from the BTS. Best results are achieved when the frame clock is set to 80 or 2560 ms, or a system frame number reset signal is used. When the sync trigger is a frame clock of 10, 20, or 40 ms, the signal generator can align frame timing. However, an 80 ms period must equal the cycle of sub-channel 0 and frame boundary to achieve frame number alignment. (The signal generator's frame number alignment can be observed on the 80 ms frame pulse from the rear panel.)

Figure 9-24 PRACH Synchronization - Frame Number Alignment



Frame Sync Trigger Status Indicator

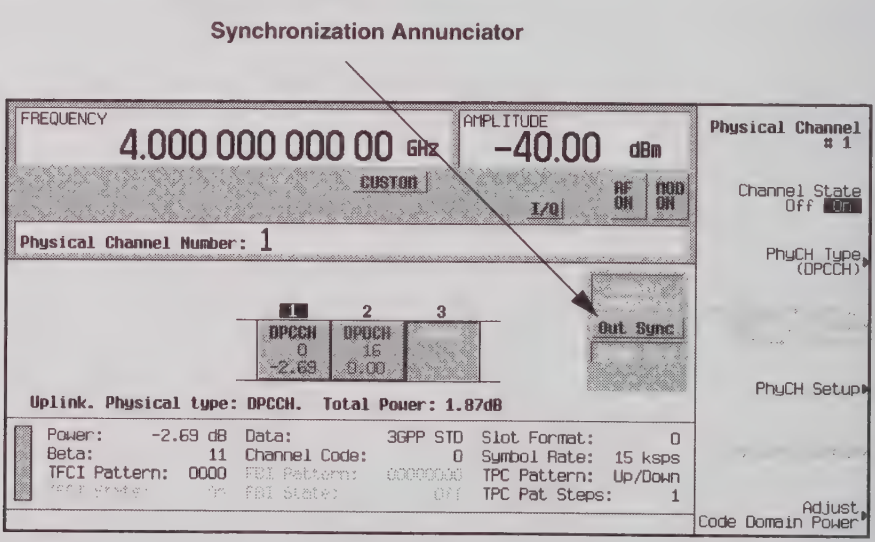
The signal generator uses a synchronization annunciator to indicate the state of the signal generator's frame synchronization and whether or not a synchronization trigger was received. Figure 9-25 shows the uplink user interface (UI) and the synchronization annunciator. When `Sync Trg` replaces `Out Sync` as the current annunciator, the frame sync trigger has either been received (dark text) or has not been received (gray text). The conditions are described as follows:

Sync Trg (grayed out):
: The frame sync trigger was *not* received after a trigger status reset.

Sync Trg (active):
: The frame sync trigger was received after the trigger status is reset.

Out Sync:
: When the synchronization annunciator indicates `Out Sync`, the signal generator is not synchronizing with the external frame sync trigger. It is only displayed when an out-of-sync condition occurs. This indicator remains active until the next frame sync trigger is received.

Figure 9-25 Front Panel Display



NOTE The trigger status reset is automatically performed whenever the frame sync trigger mode is changed or the **Apply Channel Setup** softkey activated.

Out Sync Annunciator

When the timing of the external frame synchronization signal does not match the signal generator's frame generation, the `Out Sync` annunciator is displayed. `Out Sync` replaces `Sync Trg` under these conditions.

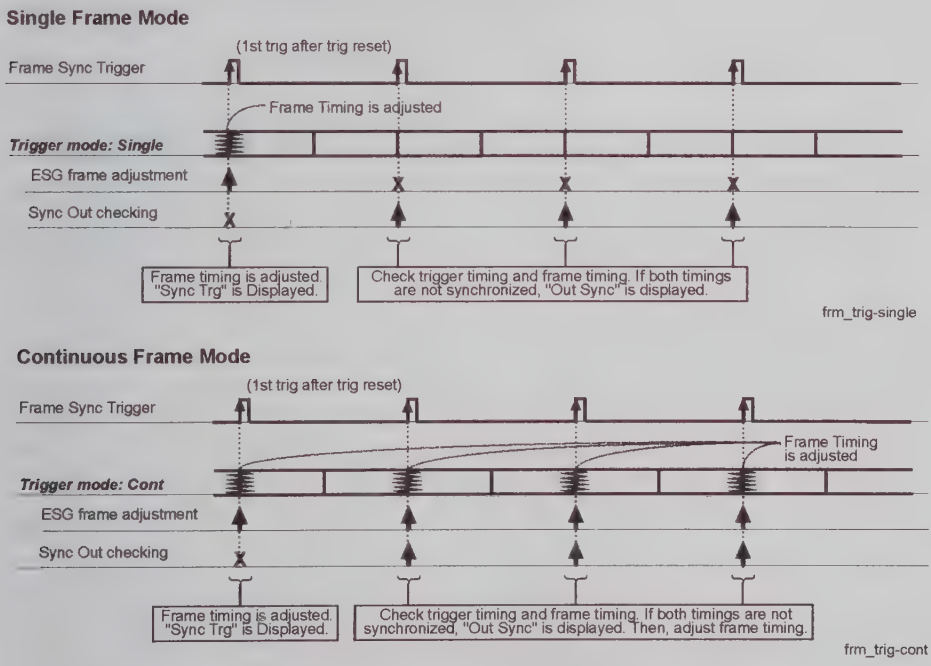
The signal generator's frame synchronization method depends on the trigger mode selected:

Single Trigger — The frame timing is adjusted at the first trigger. All triggers, except the first one are ignored and not used for signal generator frame timing.

Continuous Trigger — All external triggers are used to adjust the signal generator's frame timing.

Figure 9-26 describes trigger mode and synchronization patterns.

Figure 9-26 Trigger Mode and Synchronization


Single Frame Mode
(1st trig after trig reset)
Frame Sync Trigger
Frame Timing is adjusted
Trigger mode: Single
ESG frame adjustment
Sync Out checking
Frame timing is adjusted. "Sync Trg" is Displayed.
Check trigger timing and frame timing. If both timings are not synchronized, "Out Sync" is displayed.
frm_trig-single
Continuous Frame Mode
(1st trig after trig reset)
Frame Sync Trigger
Frame Timing is adjusted
Trigger mode: Cont
ESG frame adjustment
Sync Out checking
Frame timing is adjusted. "Sync Trg" is Displayed.
Check trigger timing and frame timing. If both timings are not synchronized, "Out Sync" is displayed. Then, adjust frame timing.
frm_trig-cont

The signal generator checks the timing difference between the external trigger and the internal frame timing whenever an external trigger is received. If the single trigger mode is selected, the signal generator checks the timing difference between the external trigger and the internal frame timing when the first trigger is received. If continuous trigger mode is selected, timing is checked at each trigger signal. If there is a timing difference in either mode, then the Out Sync annunciator is displayed.

The signal generator's behavior, when Out Sync is displayed, depends on the trigger mode used. Table 9-11 describes the signal generator's behavior for different trigger modes.

Table 9-11

Trigger Mode	ESG output signal status on Out Sync.
Single	The ESG outputs frames even if Out Sync is displayed.
Continuous	The ESG output is discontinued. The synchronization is corrupt and no output is available when Out Sync is displayed. The ESG timing is retriggered by the external trigger when this occurs.

Special Power Control Considerations When Using DPCCH/DPDCH in Compressed Mode or PRACH

When using either DPCCH/DPDCH in compressed mode or PRACH, more than a single power level is required. In addition to the rapidly varying power levels for these two channels, there are also periods of discontinuous transmission (gaps where no RF is transmitted). Under these conditions, the automatic level control (ALC) will try to counteract the rapid power variations. To prevent this, the signal generator employs ALC hold mode. However, even with ALC hold active, if the RF gap is longer than five seconds, the output level may drift significantly. Under certain conditions, such as waiting for an input trigger, the length of the RF gap is unpredictable. Under these conditions, the signal generator turns the ALC off. Table 9-12 on page 315 shows the specific settings of the DPCCH/DPDCH in compressed mode or PRACH that will turn the ALC off. Notice that the settings differ for the mechanical

attenuator.

Table 9-12 Conditions that Turn the ALC Off

Channel Type	Electronic Attenuator	Mechanical Attenuator (Option UNB)
PRACH Settings	**PRACH Trigger Source** **Immedi Trigger** softkey set to Trigger or `Message Part` data field set to AICH	**PRACH Trigger Source** **Immedi Trigger** softkey set to Trigger or `Message Part` data field set to AICH
DPCCH/DPDCH Settings	*not applicable*	all compressed frames (no normal frames)

When one of the conditions listed in Table 9-12 turns the ALC off, a manual power search must be performed in order to ensure the correct output power level. Pressing the **Apply Channel Setup** softkey executes the manual power search function. Temperature changes or changes to certain signal generator settings may cause the output power level to change over time. Even though the `Apply Needed` annunciator may be off, it is recommended that you press **Apply Channel Setup** to perform a manual power search at least every hour to maintain the correct output power level.

Waveform Clipping

In a CDMA waveform, high power peaks can cause intermodulation distortion, which generates spectral regrowth (a condition that interferes with signals in adjacent frequency bands). The clipping function allows you to reduce high power peaks.

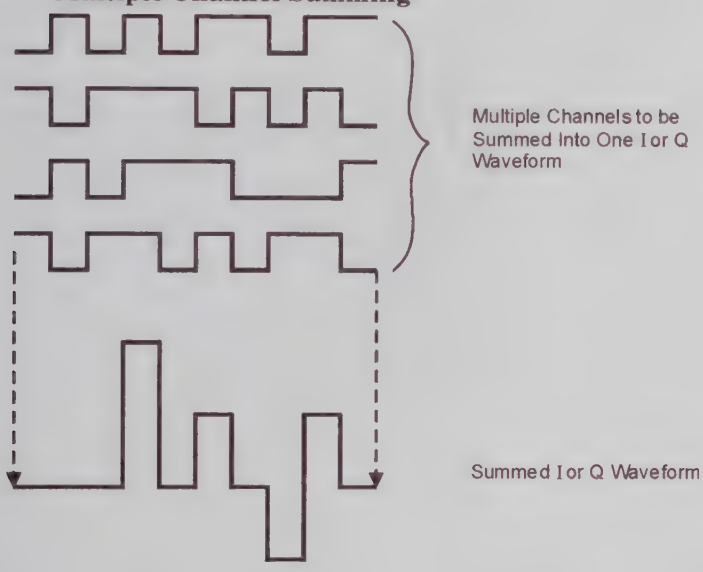
The clipping feature is available only with the Dual Arb, Arb IS-95A, Arb cdma2000, and Arb W-CDMA personalities.

How Power Peaks Develop

To understand how clipping reduces high power peaks in a CDMA signal, it is important to know how the peaks develop as the signal is constructed.

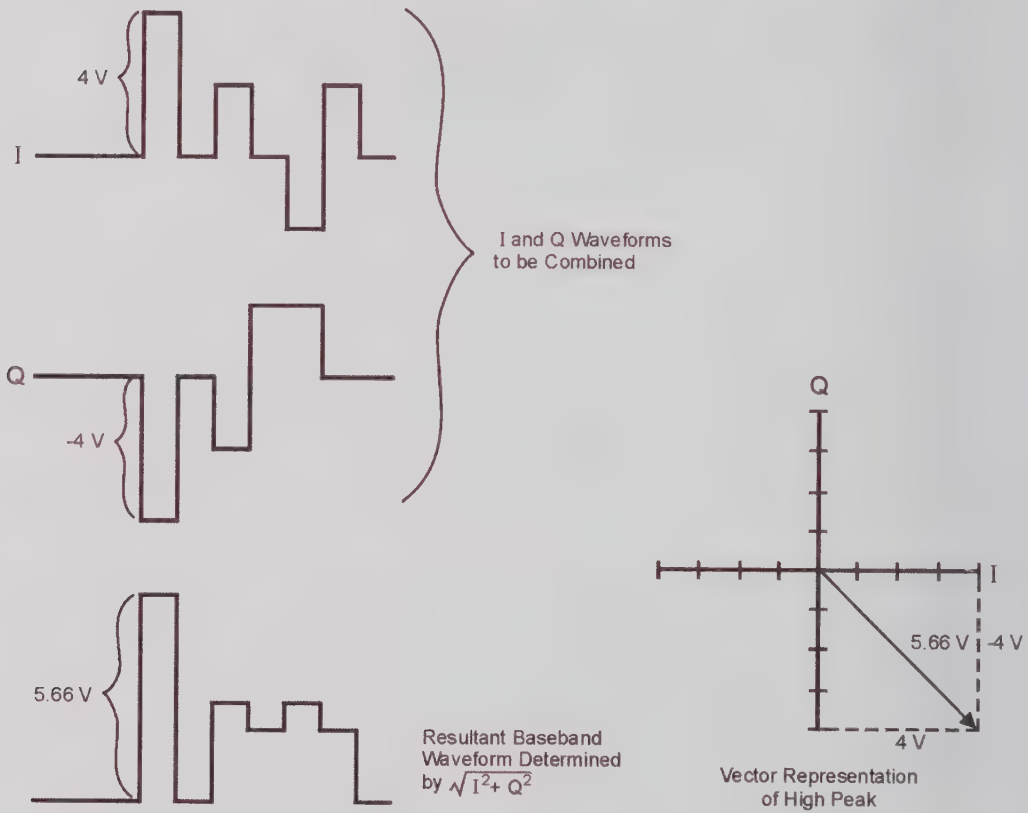
A CDMA waveform is composed of an I waveform and a Q waveform. Often, these waveforms are the summation of multiple channels (refer to Figure 9-27 on page 317). Whenever most or all of the individual channel waveforms simultaneously contain a bit in the same state (high or low), an unusually high power peak (negative or positive) occurs in the summed waveform. This does *not* happen frequently because the high and low states of the bits on these channel waveforms are random, which causes a cancelling effect.

Figure 9-27 **Multiple Channel Summing**



The I and Q waveforms combine in the I/Q modulator to create an RF waveform. The magnitude of the RF envelope is determined by the equation $\sqrt{I^2 + Q^2}$, where the squaring of I and Q always results in a positive value. Notice how simultaneous positive and negative peaks in the I and Q waveforms do not cancel each other, but combine to create an even greater peak (refer to Figure 9-28 on page 318).

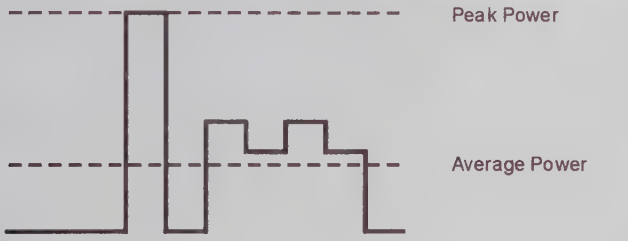
Figure 9-28 Combining the I and Q Waveforms



How Peaks Cause Spectral Regrowth

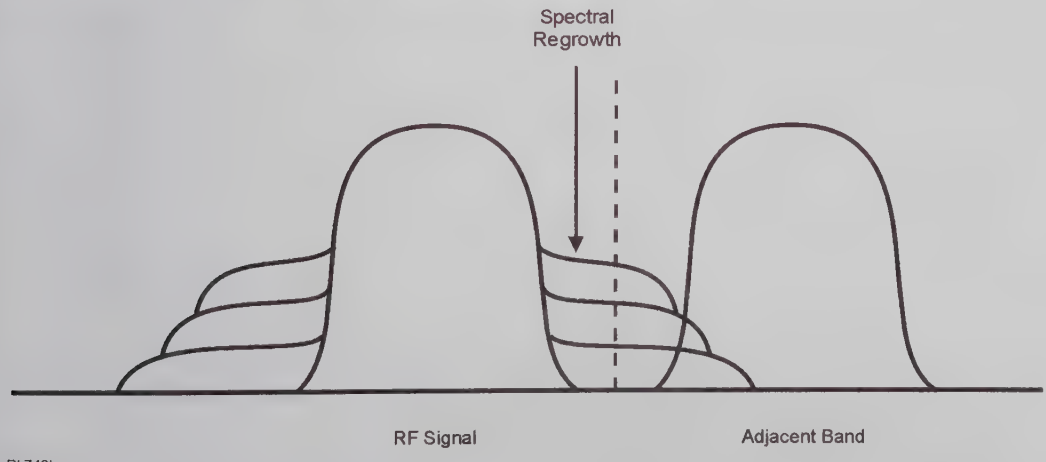
Because of the relative infrequency of high power peaks, a waveform will have a high peak-to-average power ratio (refer to Figure 9-29). Because a transmitter's power amplifier gain is set to provide a specific average power, high peaks can cause the power amplifier to move toward saturation. This causes intermodulation distortion, which generates spectral regrowth.

Figure 9-29 Peak-to-Average Power in the CDMA Waveform



Spectral regrowth is a range of frequencies that develops on each side of the carrier (similar to sidebands) and extends into the adjacent frequency bands (refer to Figure 9-30). Consequently, spectral regrowth interferes with communication in the adjacent bands. Clipping can provide a solution to this problem.

Figure 9-30 Spectral Regrowth Interfering with Adjacent Band



How Clipping Reduces Peak-to-Average Power

You can reduce peak-to-average power, and consequently spectral regrowth, by clipping the waveform to a selected percentage of its peak power. The ESG signal generator provides two different methods of clipping: circular and rectangular.

During *circular* clipping, clipping is applied to the combined I and Q RF waveform ($|I + jQ|$). Notice in Figure 9-31 that the clipping level is constant for all phases of the vector representation and appears as a circle. During *rectangular* clipping, clipping is applied to the I and Q waveforms separately ($|I|$, $|Q|$). Notice in Figure 9-32 on page 321 that the clipping level is different for I and Q; therefore, it appears as a rectangle in the vector representation. With either method, the objective is to clip the waveform to a level that effectively reduces spectral regrowth, but does *not* compromise the integrity of the signal. Figure 9-33 on page 322 uses two complementary cumulative distribution plots to show the reduction in peak-to-average power that occurs after applying circular clipping to an RF waveform.

The lower you set the clipping value, the lower the peak power that is passed (or the more the signal is clipped). Often, the peaks can be clipped successfully without substantially interfering with the rest of the waveform. Data that might be lost in the clipping process is salvaged because of the error correction inherent in the coded systems. If you clip too much of the waveform, however, lost data is irrecoverable. You may have to try several clipping settings to find a percentage that works well.

Figure 9-31 Circular Clipping

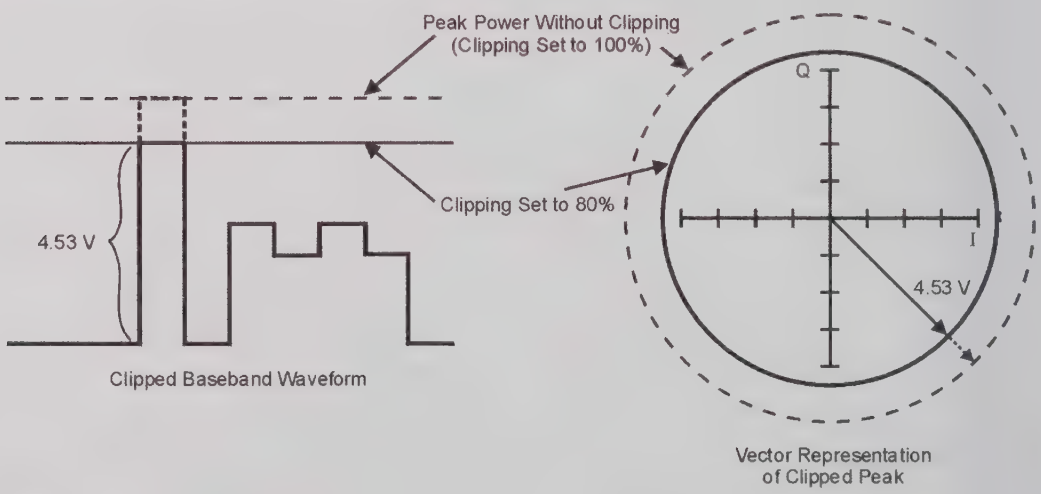
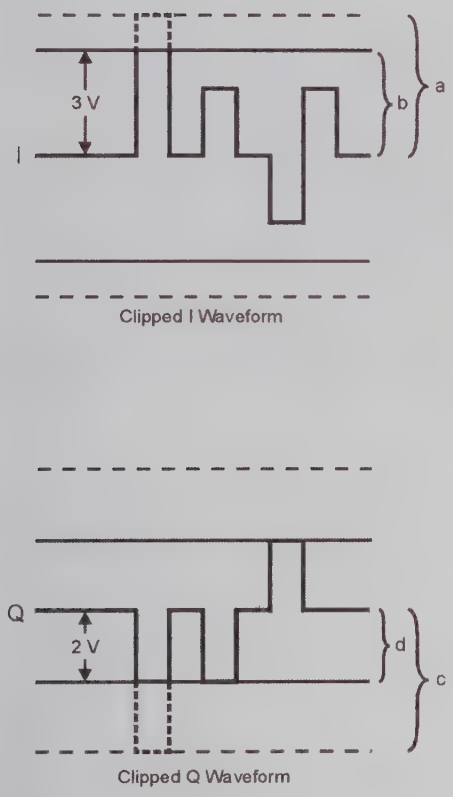
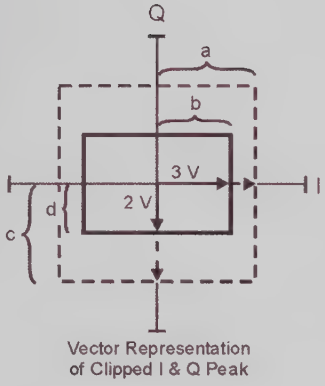


Figure 9-32 Rectangular Clipping





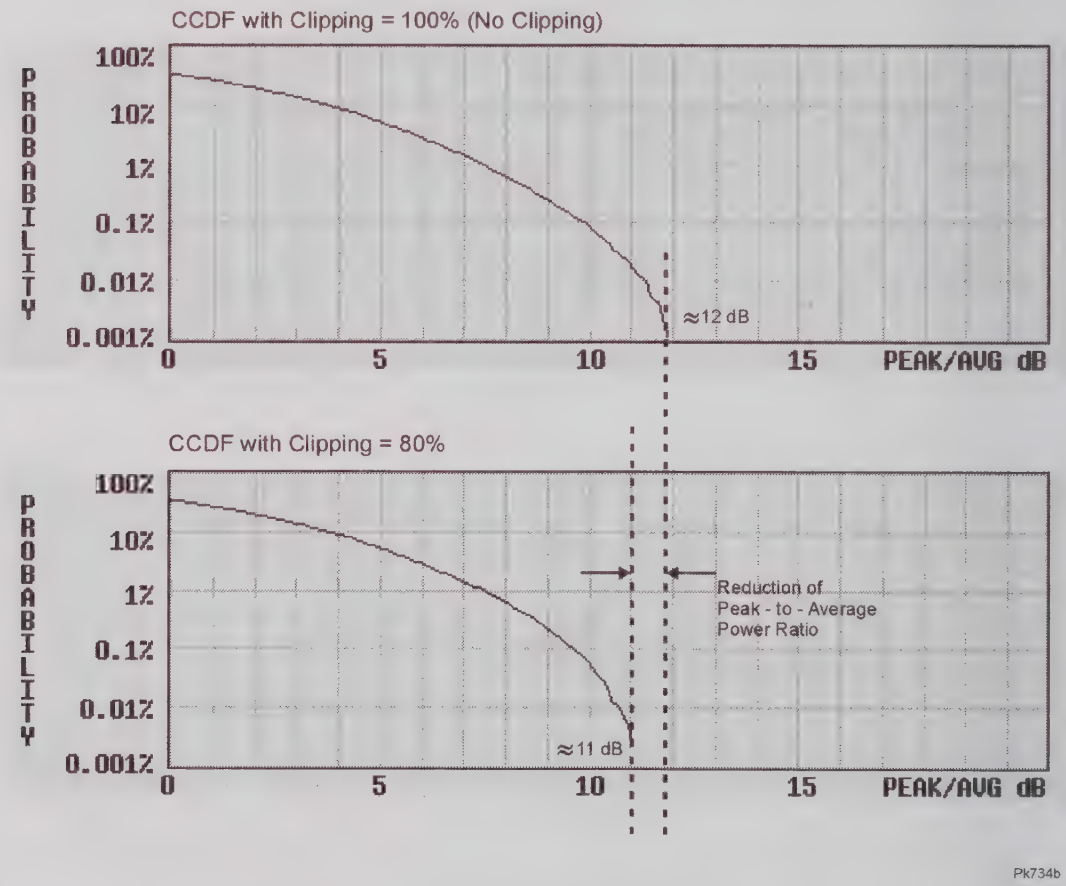
a) |I| Clipping Set to 100% (No Clipping)

b) |I| Clipping Set to 75% of Greatest Peak

c) |Q| Clipping Set to 100% (No Clipping)

d) |Q| Clipping Set to 50% of Greatest Peak

Figure 9-33 Reduction of Peak-to-Average Power



FIR Filtering Options

With CDMA personalities (not Dual Arb), the ESG signal generator allows you to choose whether clipping occurs prior to, or after, FIR filtering. Because clipped waveforms have abrupt discontinuities which can generate noise, you can select *pre*-FIR filter clipping. The FIR filter smooths any discontinuities in the clipped waveform and prevents noise. If desired, however, you can also select *post*-FIR filter clipping.

How Clipping Differs from Symbol Offset in W-CDMA

Another method used to control the power peak problem in a W-CDMA waveform is to modify the symbol-offset values of the channels that comprise either the I or Q waveform. This is accomplished by using the signal generator's W-CDMA channel table editor. Unlike clipping, which reduces existing peaks, this method attempts to *prevent* peaks.

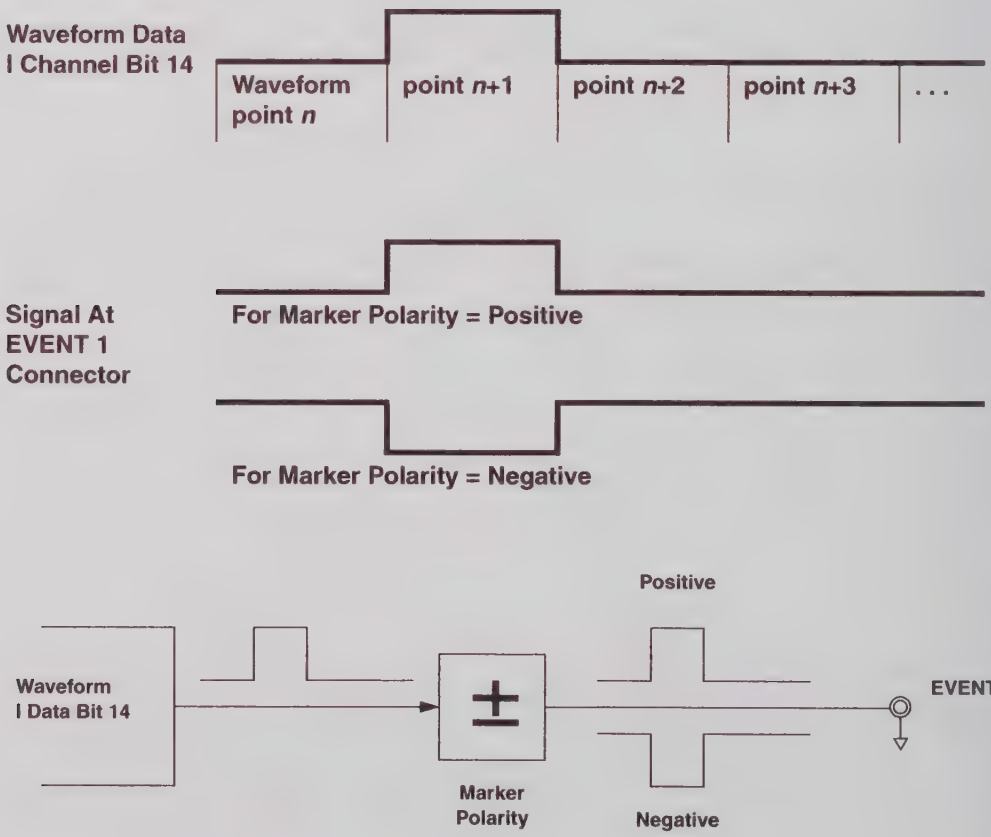
When multiple channels use a framing structure in which certain bits are designed to have the same state, these bits align and are summed to create power peaks. Offsetting the symbols in the channels prevents these bits from aligning, creating a cancelling effect. You can experiment with using the symbol-offset method in combination with clipping.

Waveform Markers

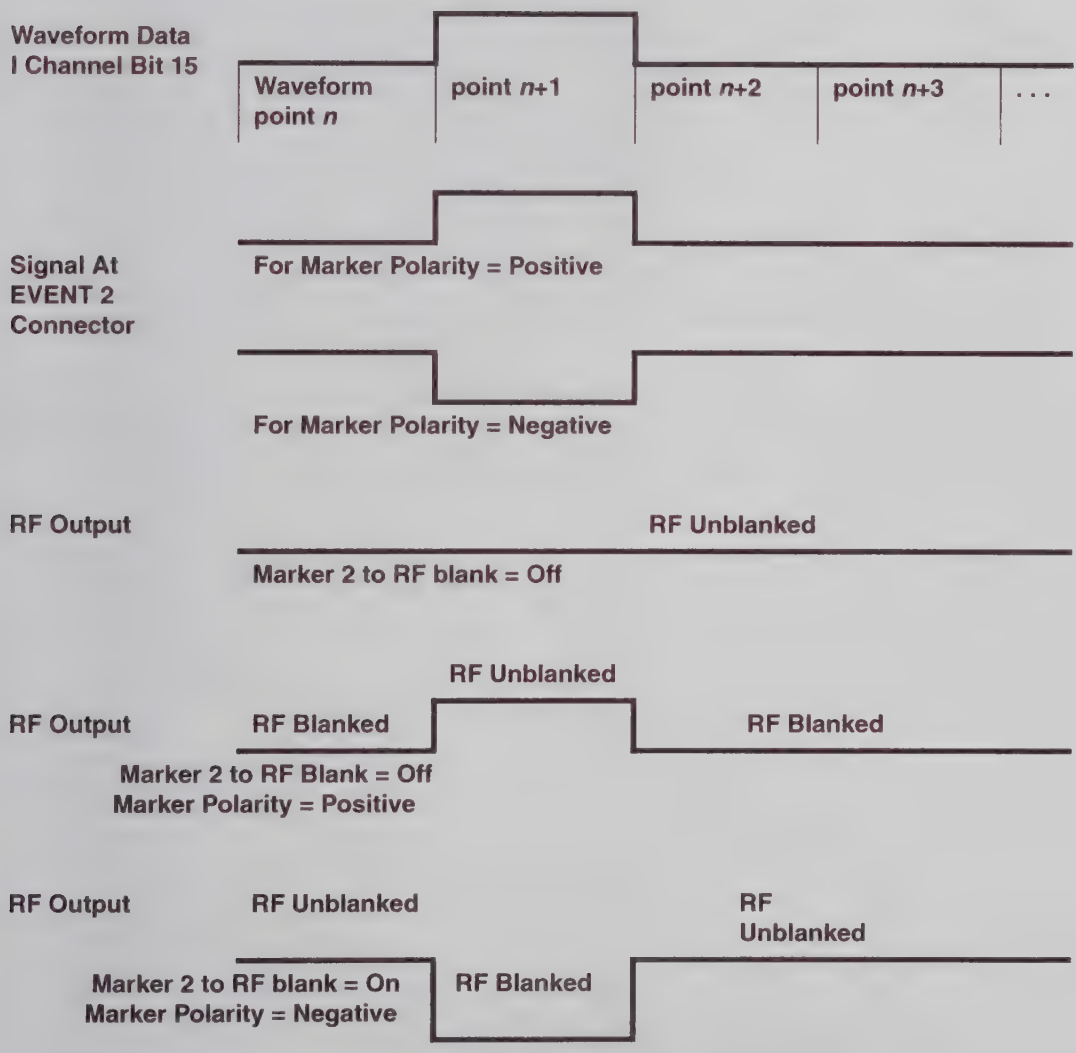
The Dual Arb personality of the signal generator has two markers that you can place on a waveform segment. Marker 1 and Marker 2 provide auxiliary output signals that are synchronized with a waveform segment. You can construct these output signals as a trigger signal to synchronize another instrument to a given portion of a waveform.

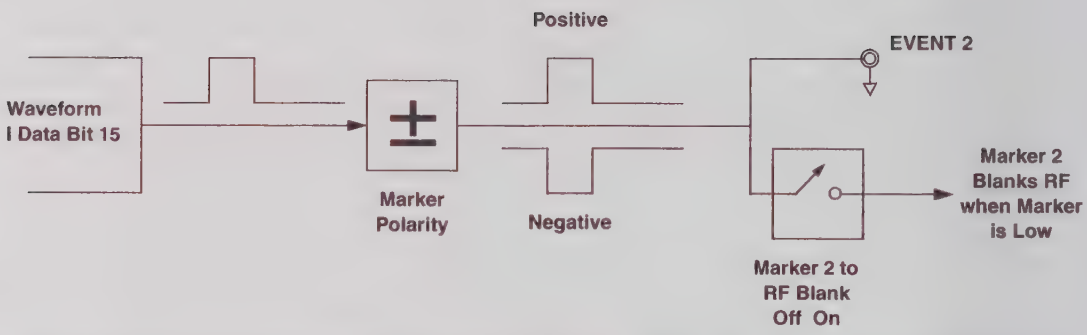
The following timing diagrams describe the effects of Markers 1 and 2 on the state of the signal at the EVENT 1 and EVENT 2 rear panel connectors.

Marker 1 and EVENT 1



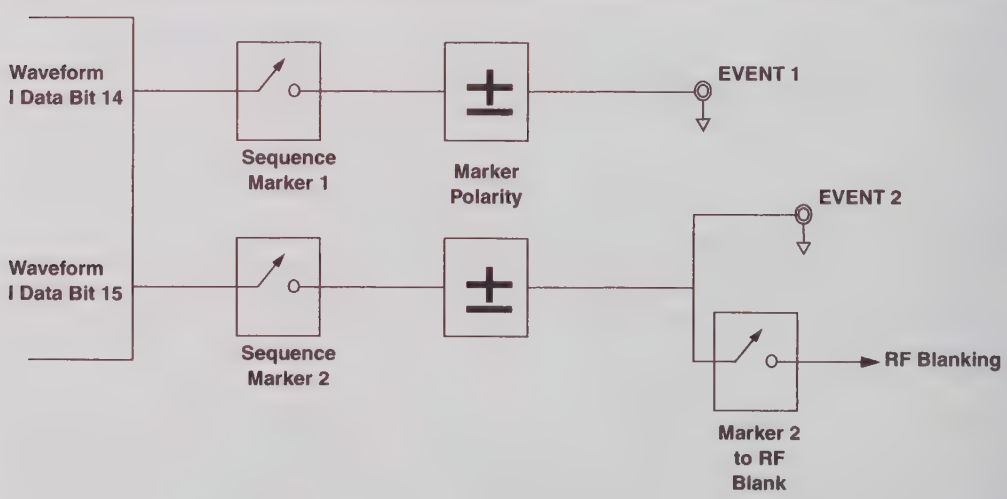
Marker 2 and EVENT 2





A waveform sequence comprises waveform segments. When you combine segments to form a sequence, you can enable or disable Marker 1 and/or Marker 2 on a segment-by-segment basis.

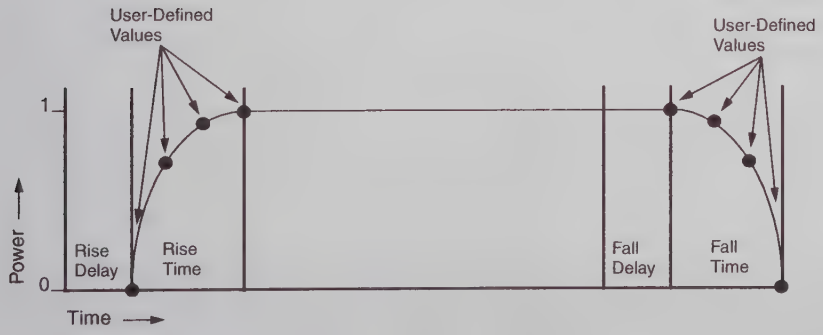
When you select a sequence to output, the markers embedded in any one segment of that sequence are output only if the sequence marker for that segment is enabled (toggled on). This makes it possible to output markers for some segments in a sequence, but not for others.



Burst Shape

The default burst shape of each format is implemented according to the standards of the format selected. You can, however, modify the following aspects of the burst shape:

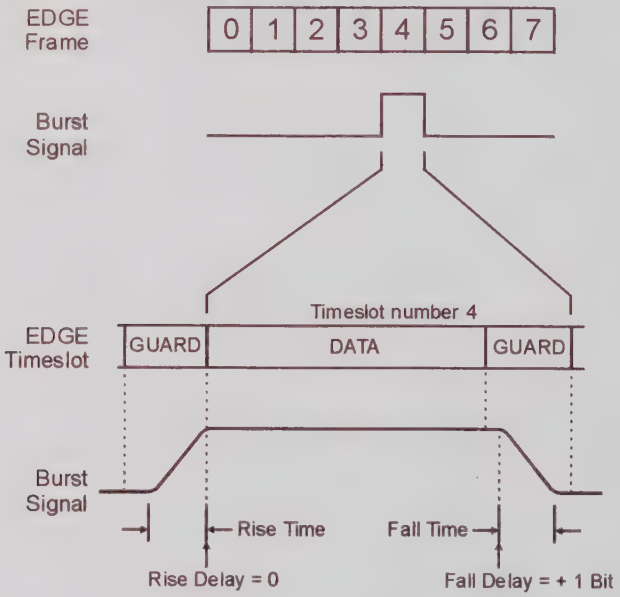
Rise time	the period of time, specified in bits, where the burst increases from a minimum of –70 dB (0) to full power (1).
Fall time	the period of time, specified in bits, where the burst decreases from full power (1) to a minimum of –70 dB (0).
Rise delay	the period of time, specified in bits, that the start of the burst rise is delayed. Rise delay can be either negative or positive. Entering a delay other than zero shifts the full power point earlier or later than the beginning of the first useful symbol.
Fall delay	the period of time, specified in bits, that the start of the burst fall is delayed. Fall delay can be either negative or positive. Entering a delay other than zero shifts the full power point earlier or later than the end of the last useful symbol.
User-defined burst shape	up to 256 user-entered values which define the shape of the curve in the specified rise or fall time. The values can vary between 0 (no power) and 1 (full power) and are scaled linearly. Once specified, the values are resampled as necessary to create the cubic spline that passes through all of the sample points.



Burst shape maximum rise and fall time values are affected by the following factors:

- the symbol rate
- the modulation type

When the rise and fall delays equal 0, the burst shape is attempting to synchronize the maximum burst shape power to the beginning of the first valid symbol and the ending of the last valid symbol of the timeslot. The following figure illustrates a bursted signal in an EDGE frame with a rise delay of 0 and a fall delay of +1 bit.



The signal generator firmware computes optimum burst shape based on the settings you've chosen for modulation. You can further optimize burst shape by lining up the data portion with the modulation. For example, if you're designing a new modulation scheme, do the following:

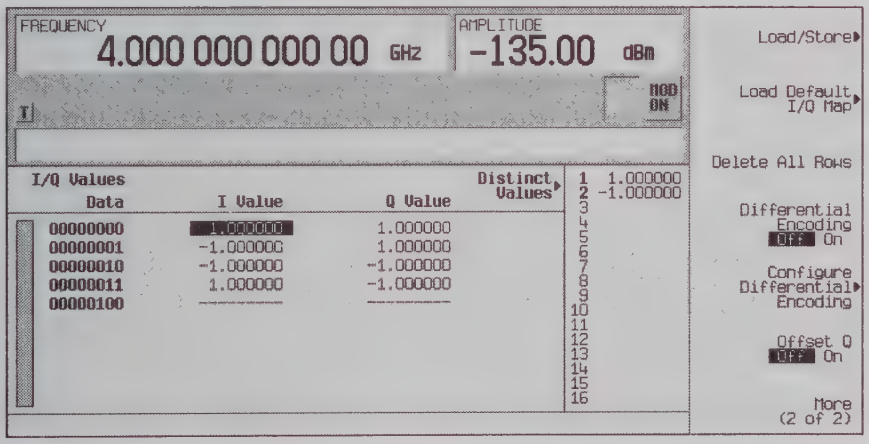
- Adjust the modulation and filtering to set the spectrum you want.
- Turn on framing.
- Adjust the burst rise and fall delay and rise and fall time for the timeslots.

If you find that the error vector magnitude (EVM) or adjacent channel power (ACP) increases when you turn bursting on, you can adjust the burst shape to assist with troubleshooting.

Differential Encoding

Differential encoding is a digital-encoding technique whereby a binary value is denoted by a signal *change* rather than a particular signal state. Using differential encoding, binary data in any user-defined I/Q or FSK modulation can be encoded during the modulation process via symbol table offsets defined in the Differential State Map.

For example, consider the signal generator's default 4QAM I/Q modulation. With a user-defined modulation based on the default 4QAM template, the `I/Q Values` table editor contains data that represent four symbols (00, 01, 10, and 11) mapped into the I/Q plane using two distinct values, 1.000000 and -1.000000. These four symbols can be differentially encoded during the modulation process by assigning symbol table offset values associated with each data value. The following illustration shows the 4QAM modulation in the `I/Q Values` table editor.

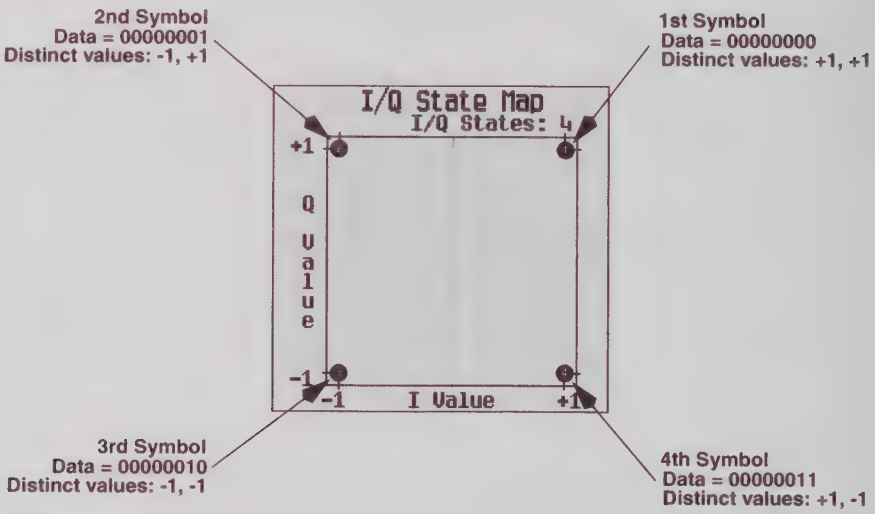


NOTE The number of bits per symbol can be expressed using the following formula. Because the equation is a ceiling function, if the value of x contains a fraction, x is rounded up to the next whole number.

$$x = \lceil Log_2(y) \rceil$$

Where x = bits per symbol, and y = the number of differential states.

The following illustration shows a 4QAM modulation I/Q State Map.



How Differential Encoding Works

Differential encoding employs offsets in the symbol table to encode user-defined modulation schemes. The `Differential State Map` table editor is used to introduce symbol table offset values which in turn cause transitions through the I/Q State Map based on their associated data value. Whenever a data value is modulated, the offset value stored in the Differential State Map is used to encode the data by transitioning through the I/Q State Map in a direction and distance defined by the symbol table offset value.

Entering a value of +1 will cause a 1-state forward transition through the I/Q State Map, as shown in the following illustration.

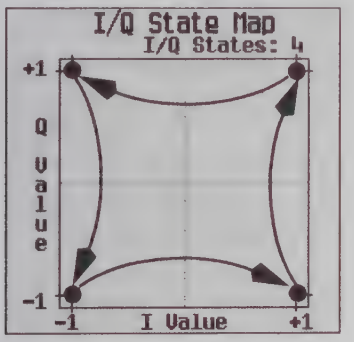
NOTE The following I/Q State Map illustrations show all of the possible state transitions using a particular symbol table offset value. The actual state-to-state transition would depend upon the state in which the modulation had started.

As an example, consider the following data/symbol table offset values.

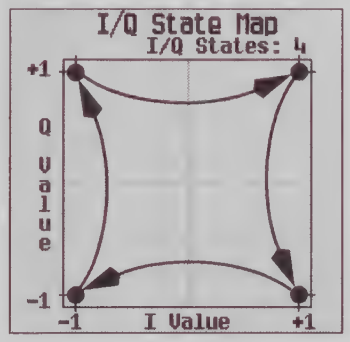
Data	Offset Value
00000000	+1
00000001	–1
00000010	+2
00000011	0

These symbol table offsets will result in one of the transitions, as shown.

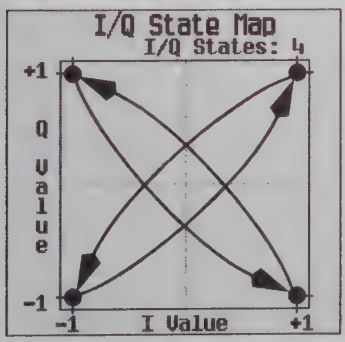
Data Value 00000000
with Symbol Table Offset +1
transition 1 state forward



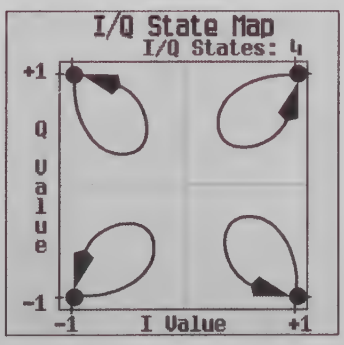
Data Value 00000001
with Symbol Table Offset -1
transition 1 state backward



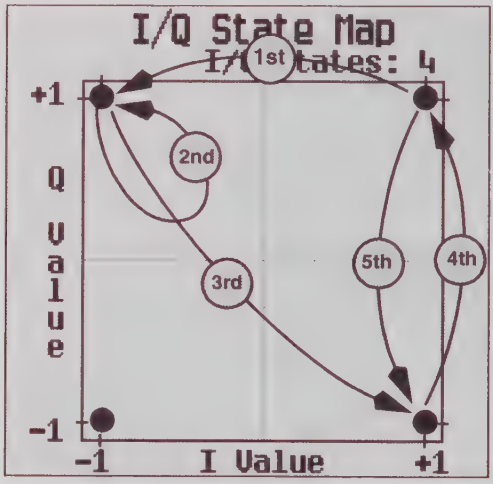
Data Value 00000010
with Symbol Table Offset +2
transition 2 states forward

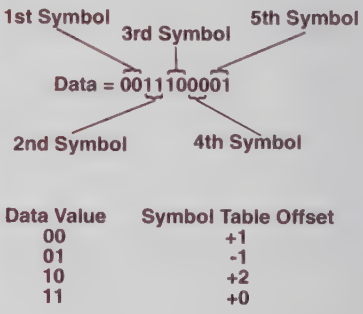


Data Value 00000011
with Symbol Table Offset 0
no transition



When applied to the user-defined default 4QAM I/Q map, starting from the 1st symbol (data 00), the differential encoding transitions for the data stream (in 2-bit symbols) 0011100001 appear in the following illustration.





Data Value	Symbol Table Offset
00	+1
01	-1
10	+2
11	+0

As you can see from the previous illustration, the 1st and 4th symbols, having the same data value (00), produce the same state transition (forward 1 state). In differential encoding, symbol values do not define location; they define the direction and distance of a *transition* through the I/Q State Map.

For instructions on configuring differential encoding, see "Using Differential Encoding" on page 239.

Differential Data Encoding

In real-time I/Q baseband digital modulation waveforms, data (1's and 0's) are encoded, modulated onto a carrier frequency and subsequently transmitted to a receiver. In contrast to differential encoding (described on page 329), differential *data* encoding modifies the data stream *prior* to I/Q mapping. Where differential encoding encodes the raw data by using symbol table offset values to manipulate I/Q mapping at the point of modulation, differential data encoding uses *the transition from one bit value to another* to encode the raw data.

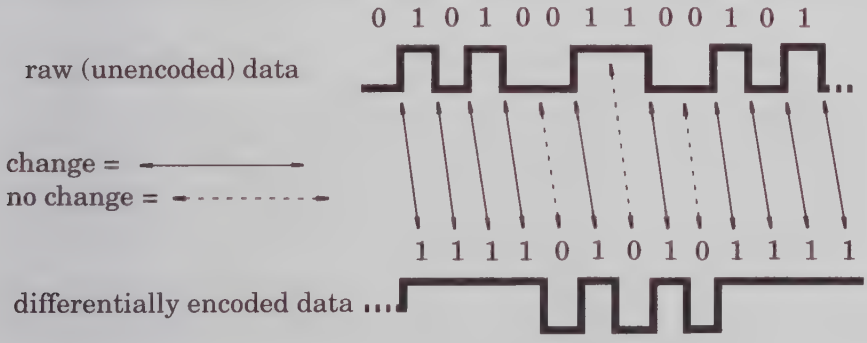
Differential data encoding modifies the raw digitized data by creating a secondary, encoded data stream that is defined by *changes* in the digital state, from 1 to 0 or from 0 to 1, of the raw data stream. This differentially encoded data stream is then modulated and transmitted.

In differential data encoding, a *change* in a raw data bit's digital state, from 1 to 0 or from 0 to 1, produces a 1 in the encoded data stream. *No change* in digital state from one bit to the next, in other words a bit with a value of 1 followed by another bit with a value of 1 or a bit with a value of 0 followed by the same, produces a 0 in the encoded data. For instance, differentially encoding the data stream containing 01010011001010 renders 1111010101111.

Differential data encoding can be described by the following equation:

$$transmittedbit(i) = databit(i-1) \oplus databit(i)$$

For a bit-by-bit illustration of the encoding process, see the following illustration.



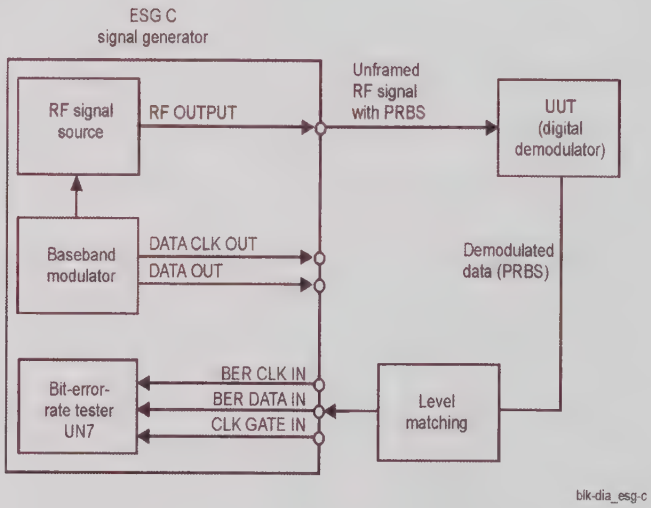
Bit Error Rate Tester–Option UN7

The bit error rate test (BERT) capability allows you to perform bit error rate (BER) analysis on digital communications equipment. This enables functional and parametric testing of receivers and components including sensitivity and selectivity.

Block Diagram

When measuring BER, a clock signal that corresponds to the unit under test (UUT) output data must be input to the BER CLK IN connector. If the clock is not available from the UUT, use the DATA CLK OUT signal from the ESG baseband modulator.

Figure 9-34



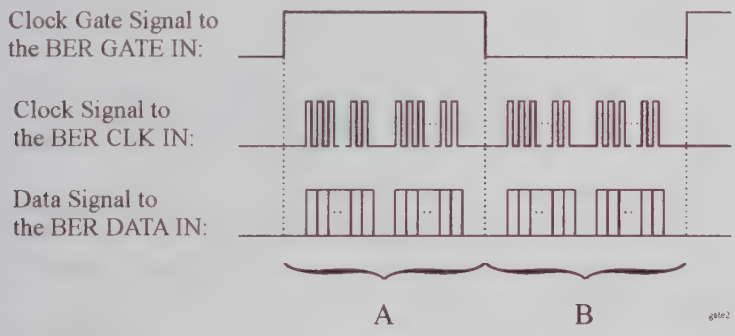
Clock Gate Function

When you use the clock gate function, the clock signal to the BER CLK IN connector is valid only when the clock gate signal to the BER GATE IN connector is ON.

Press the **Clock Gate Off On** softkey to toggle the clock gate function off and on.The **Clock Gate Polarity Neg Pos** softkey sets the input polarity of the clock gate signal supplied to the rear panel BER GATE IN connector. When you select **Pos** (positive), the clock signal is valid when the clock gate signal is high; when you select **Neg** (negative), the clock signal is valid when the clock gate signal is low.

The following figure shows an example of the clock gate signal.

Figure 9-35



- When the **Clock Gate Off On** softkey is set to Off:

  The clock signal in both "A" and "B" parts is effective and no gate function is required. Therefore, the bit error rate is measured using the clock and data signal in both "A" and "B" parts.

- When the **Clock Gate Off On** softkey is set to **On**, and the **Clock Gate Polarity Neg Pos** softkey is set to **Pos**:

  The clock signal in "A" part is effective. Therefore, the bit error rate is measured using the clock and data signals in "A" part.

- When the **Clock Gate Off On** softkey is set to **On**, and the **Clock Gate Polarity Neg Pos** softkey is set to **Neg**:

  The clock signal in "B" part is effective. Therefore, the bit error rate is measured using the clock and data signals in "B" part.

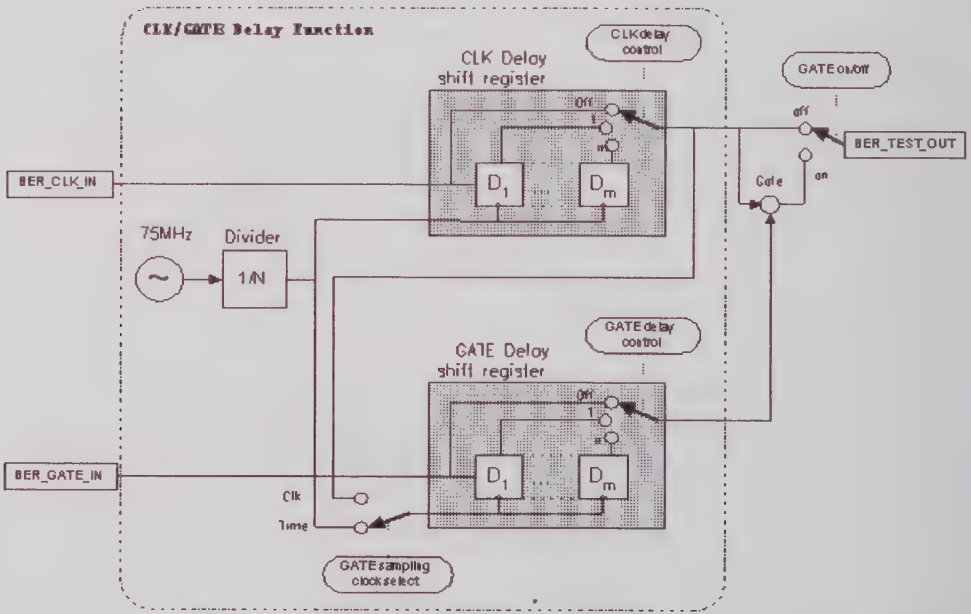
Clock/Gate Delay Function

This function enables you to restore the timing relationship between the clock/gate timing as it passes through the unit under test (UUT) and the packet data.

The shifted clock signal is emitted from pin 20 of the AUX I/O rear panel connector. When you use the clock delay function, the clock signal to the BER CLK IN connector is delayed by the clock delay function. When you use the gate delay function with the clock gate function, the clock signal is gated by the gate signal which is delayed by the gate delay function.

To see the signal flow using the clock and gate functions, refer to Figure 9-36.

Figure 9-36
Signal Flow



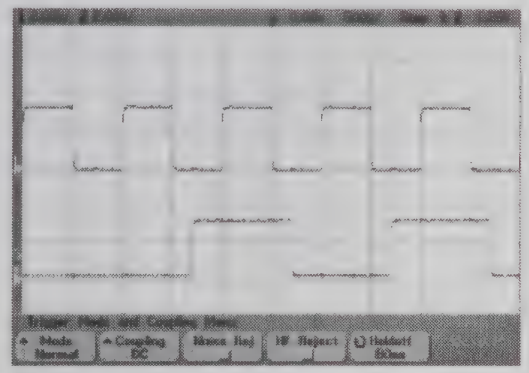
Clock Delay Function

In this example, the clock delay function is off. Figure 9-37 shows the input of the internal error detector of UN7 through AUX I/O and indicates that the data is delayed from the clock.

Figure 9-37

CH1

CH2



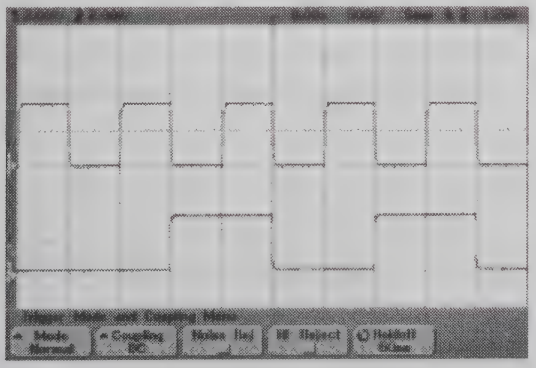
CH1: BER TEST OUT (pin 20 of AUX I/O connector)
CH2: BER MEAS END (pin 1 of AUX I/O connector)

In this example, the clock delay function is on. The rising edge of the clock was delayed by 200 ns and was adjusted to the center of the data. Figure 9-38 indicates the result of the using the clock delay function.

Figure 9-38

CH1

CH2

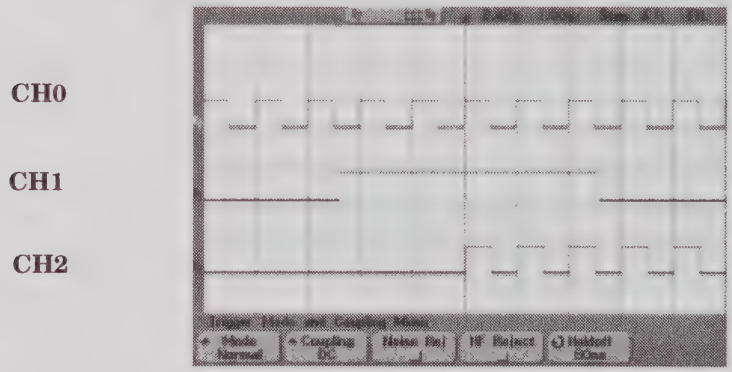


Gate Delay Function in the Clock Mode

To use this function, the clock must be set to continuous mode.

In this example, the clock is used to delay the gate function. The clock of the internal error detector was gated by the gate signal which is delayed by two clocks. Figure 9-39 shows that CH0 and CH1 are the input of the clock and data from the rear panel input connectors of UN7. CH2 is the gated clock through the AUX I/O connector.

Figure 9-39

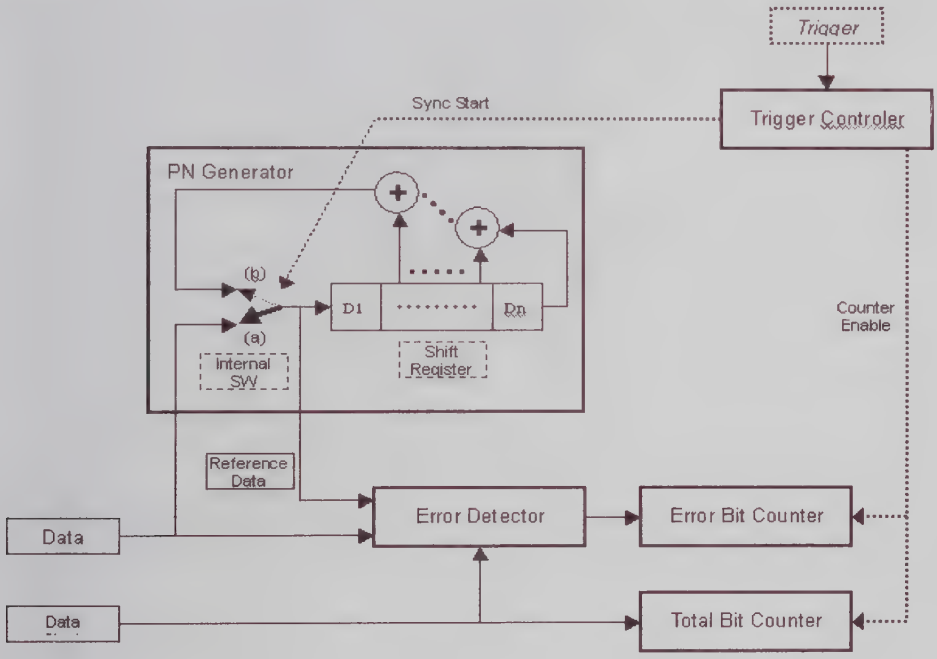


CH0: BER CLK IN (rear panel SMB connector)
CH1: BER GATE IN (rear panel SMB connector)
CH2: BER TEST OUT (pin 20 of AUX I/O connector)

Triggering

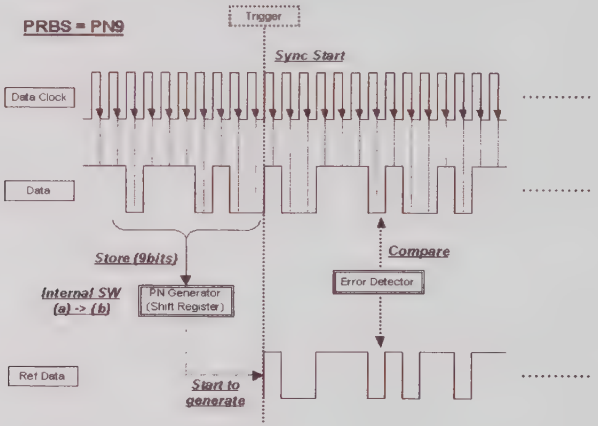
This section describes the operating principles of the triggering function for Option UN7. To see the signal flow of the triggering function refer to Figure 9-40.

Figure 9-40



In this example, the triggering sequence is where you have an incoming data clock and data bit sequences, the trigger is active, and the BER measurement begins. Refer to Figure 9-41.

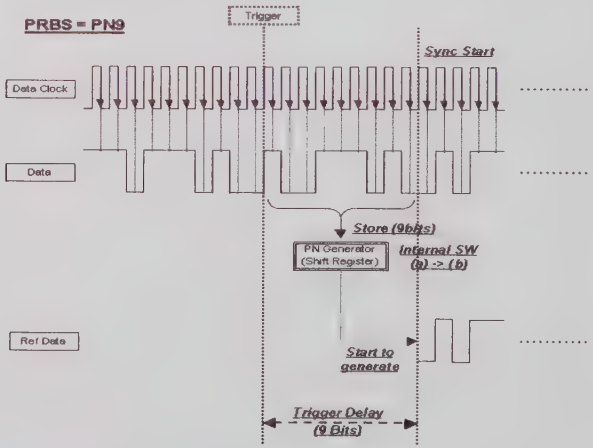
Figure 9-41



In this example, synchronization occurs after receiving a trigger.

The reference data is generated by stored data bits. If the BER measurement accepts data bits immediately after receiving a trigger, set the trigger delay to On and the trigger delay count to a value corresponding to the data format. For PN9 set the delay to 9. Refer to Figure 9-42.

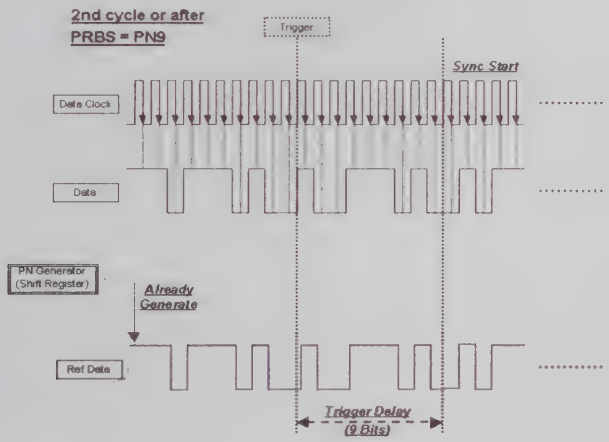
Figure 9-42



In this example, the triggering sequence is where the trigger delay is active with a cycle count.

The reference data is generated by stored data bits. If the BER measurement accepts data bits immediately after receiving a trigger, set the trigger delay to On and the trigger delay count to a value corresponding to the data format. For PN9 set the delay to 9. If the cycle count is set to more than 1, it is not necessary to store data bits and no unnecessary delay occurs. Refer to Figure 9-43 and "Repeat Measurements" on page 343.

Figure 9-43



Data Processing

Data Rates

Data rates up to 60 MHz are supported for BER analysis on un-framed or framed PN sequences. Note that the BER analyzer supports only continuous PN sequences.

Synchronization

Immediately after the trigger event, the DSP for the BER measurement tries to establish synchronization using the first incoming bit stream.

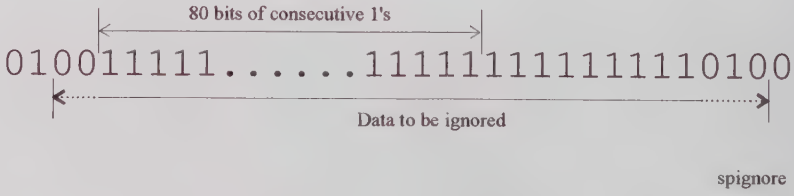
If the **Bit Delay Off On** softkey is set to **On**, the number of bits specified by the **Delayed Bits** are ignored. The synchronization checking is repeated using an error-free bit string, lengthened by the **Delayed Bits**, until synchronization is established.

When the **BERT Resync Off On** softkey is set to **On**, the BER measurements will automatically be restarted if the intermediate BER measurement result exceeds the value specified by the **BERT Resync Limits**.

Special Pattern Ignore Function

The special pattern ignore function is especially useful when performing BER analysis on radios that generate consecutive 0's or 1's data for traffic channels when they fail to detect the Unique Word or lose synchronization. If 80 consecutive incoming data bits are all either 1's or 0's, when the **Spcl Pattern Ignore Off On** softkey is set to **On**, all of the consecutive 0's or 1's (and several bits before and after the consecutive 0's or 1's) are ignored. The following figure shows the operation example of the special pattern ignore function.

Figure 9-44



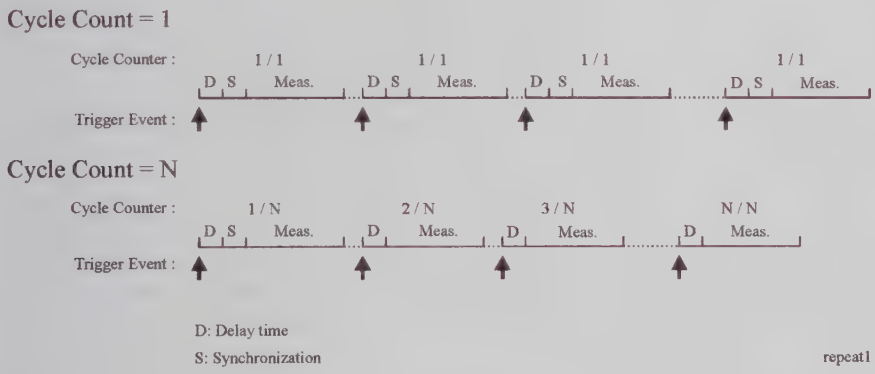
Pass/Fail Judgement

There are two pass/fail judgement update modes: cycle end and fail hold. With cycle end selected, either pass or fail judgement is made for the results of each measurement cycle. With fail hold selected, the fail judgement is retained whenever a failure occurs during one loop of BER repeat measurements. Fail hold mode allows you to determine when a failure occurs at least once during an entire cycle of measurements.

Repeat Measurements

When the **Cycle Count** softkey is set to more than 1, the synchronization performed before the start of each measurement is only executed the first time; then it keeps track of the clock signal and the PRBS generation for the incoming data. This function can reduce the total time for BER measurements. Also, once synchronization is established, it is retained even if the BER measurement result degrades. You may wish to adjust the signal level to find a specific BER value. However, once synchronization is lost in a repeat sequence, it will not be restored until the initiation of a new sequence. The following figure shows an example of the repeat measurements.

Figure 9-45

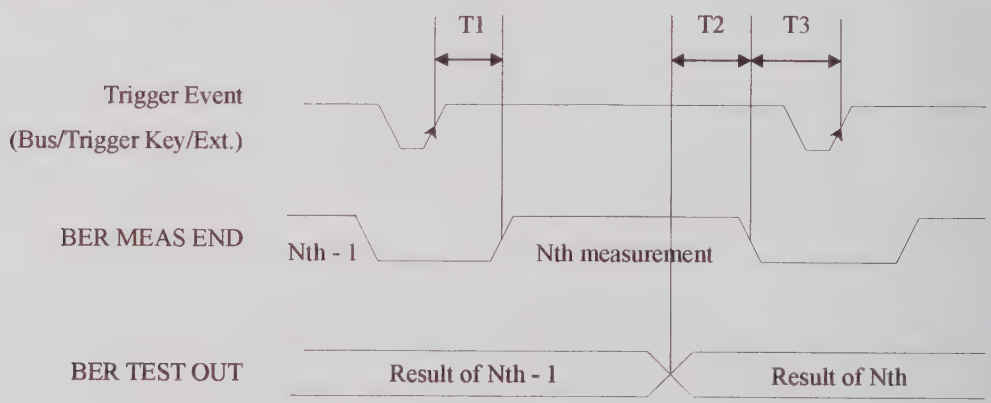


Testing Signal Definitions

The timing diagram Figure 9-46, "Testing Signal Definitions," shows the relationships between a trigger event and the output signals at the BER MEAS END and BER TEST OUT connectors.

If a BER MEAS END signal stays high following a trigger event, the BER measurement is in progress and other trigger events are ignored. This state is stored in the status register and can be queried.

Figure 9-46 Testing Signal Definitions



timing

- T1 is a firmware handling time measured from a Trigger event to the rising edge of a BER MEAS END signal.
- T2 is a firmware handling time measured from the falling edge of a BER TEST OUT signal to the falling edge of the BER MEAS END signal.
- T3 is a minimum requirement time measured from the falling edge of the BER MEAS END signal to the next trigger event. T3 should be greater than 0 second.

The pulse output of the BER TEST OUT for the Nth-1 test result ends prior to the falling edge of the BER MEAS END signal for the Nth measurement; so you can use this edge to start latching the Nth test result.

RF Loopback BER–Option 300

Synchronization

Synchronizing the test equipment to the base transceiver station (BTS) is a prerequisite to the BTS looping back the selected traffic channel (TCH). This can be achieved in two ways: BCH Sync or TCH Sync.

BCH Sync The BTS is set to transmit to the test equipment a BCH on timeslot 0 of a selected absolute radio frequency channel number (ARFCN). The test equipment uses the BCH signal to determine its required TCH transmit timing.

On completion, the BTS may be switched into loopback mode on any selected ARFCN and timeslot number.

TCH Sync This is a very quick mode of synchronization, but take care initially to set the receiver to the correct timeslot number being transmitted by the BTS.

In this mode the base station must transmit a signal on the selected timeslot prior to data being looped back. In some base stations this will happen as soon as a timeslot is set to loopback, regardless of whether the signal to the BTS has the correct timing. In other base stations, the BTS may need to be set to transmit a signal in the selected timeslot prior to achieving synchronization.

The test equipment can lock to this signal if it contains the correct midamble. Once synchronized, the test equipment uses this information to determine the required TCH transmit timing. If the BTS is set accordingly, any timeslot can be transmitted with the correct timing to enable it to be looped back by the BTS to the receiver (VSA/ESG).

NOTE The TCH sync mode relies on the user to set the correct timeslot number into both ESG transmitter and receiver during synchronization. Thereafter, the ESG can correctly test any timeslot since its relative timing is defined.

This capability can be used to speed up testing of consecutive timeslots in manufacture. TCH sync mode can be used to test all timeslots consecutively without changing a single setting on the ESG/VSA. All that is required is to consecutively loopback each timeslot using the BTS man-machine interface (MMI) and resynchronize and trigger the ESG.

PN synchronization is also a prerequisite to BER measurements. This is automatic but is dependent on prior BCH or TCH synchronization.

The pattern to be recognized (PN9 or PN15) is determined by the corresponding transmit timeslot pattern selection.

Erased Frame Detection

When an incorrect CRC in an uplink speech frame is detected by a BTS conforming to the GSM standards, the BTS substitutes an all-zero speech frame.

In the loopback mode, the BTS transmitter then recodes this substituted zero speech frame before transmission back to the test equipment receiver (VSA/ESG).

The ESG receiver detects any coded all-zeros speech frames in the returned downlink signal and increments the (erased) frame event count.

Downlink Errors

The loopback method of measuring BTS receiver BER quality requires a high quality downlink return path which introduces no errors.

To cater for the situation where the downlink path is faulty, the VSA/ESG provides a measure of downlink quality based on TCH payload errors detected by convolutional decoding of the return path. This records errors introduced into the TCH between the downlink coding (BTS transmitter) and decoding (VSA/ESG) processes and should normally be zero. For any payload errors detected during a measurement, the measurement is extended by a speech frame for every downlink error detected.

If a downlink problem results in errors introduced into the downlink midamble, the measurement aborts, providing further security against downlink problems.

Frame Structure

GSM Frame Structure

26-frame TCH multiframe structure.
Frames: Frame 12 (SACCH) and frame 25 (idle) empty.
Identical repetitive frames. Content as per ESG GSM capability.

GSM Received Data

The Table 9-13 shows the minimum requirements for the GSM received data frame structure

during synchronization to the BTS and during measurements.

Table 9-13 GSM Received Data

During BCH Synchronization	
TS0	51-frame BCH Multiframe Structure
	SCH in frames 1, 11, 21, 31, 41
TS1-7	No SCH, but otherwise, don't care
During TCH Synchronization	
TSX	26-frame TCH Multiframe Structure
	Frame 25 idle
	Frame 12 don't care
	Other frames TCH
During Measurements	
Timeslot under test	26-frame full-rate voice TCH Multiframe Structure
TCH Frames 0-11, 13-24	Content determined by transmitted signal (looped by BTS except for errored speech frames, i.e. speech frames with bad CRC)
Frames 12, 25	Don't care

GSM Transmit Data

The minimum GSM transmit data requirements for the loopback test are a fully GSM-coded 26-channel multiframe with either PN9 or PN15 in the payload. This is selected on the ESG by setting the timeslot under test to normal and selecting the PN9 or PN15 multiframe PN pattern.

To meet the GSM standards requirements for full conformance, the adjacent timeslots should be loaded with fully GSM-coded data. The ESG offers full flexibility of loading all timeslots.

Edge Frame Structure

52-frame PDCH multiframe structure.

Frames: 12 blocks of 4 frames, 2 idle frames, and 2 frames used for the PTCCH.

GPS

Option Overview

This real-time personality simulates GPS satellite transmissions for single channel receiver testing. The following list shows some of the features for building a basic signal:

- P code generation at 10.23 Mcps with the standard GPS 10.23 Mcps reference
- C/A code generation at 1.023 Mcps with the standard GPS 10.23 Mcps reference
- navigation data output at 50 bps using PN9, PN15, a fixed 4-bit pattern, user file, or default data (TLM mode) for encoding with the C/A code
- three selectable ranging codes: C/A, P, or C/A+P
- satellite ID range of 1 to 32 with an additional range of 33 to 37 for other uses
- three selectable data modes that include a TLM mode, which uses a formatted handover word (HOW) and telemetry (TLM) word (refer to "Data Modes and Subframe Structures" on page 349 for more information)
- simulated doppler shifting with a 250 kHz range
- selectable internal or external chip clock reference source

A basic signal setup is provided when the signal generator is preset using factory-defined attributes (C/A ranging code, satellite ID of 1, zero doppler shift, and the Raw data mode using PN9 data with the standard 10.23 Mcps reference clock). These attributes are available when Normal is selected using the **Preset Normal User** softkey. Refer to the *Key and Data Field Reference* for more information.

The satellite ID numbers operate according to the GPS standards; they match the pseudorandom numbers (PN) that are used to generate the C/A and P codes and they also dictate the amount of chip delay.

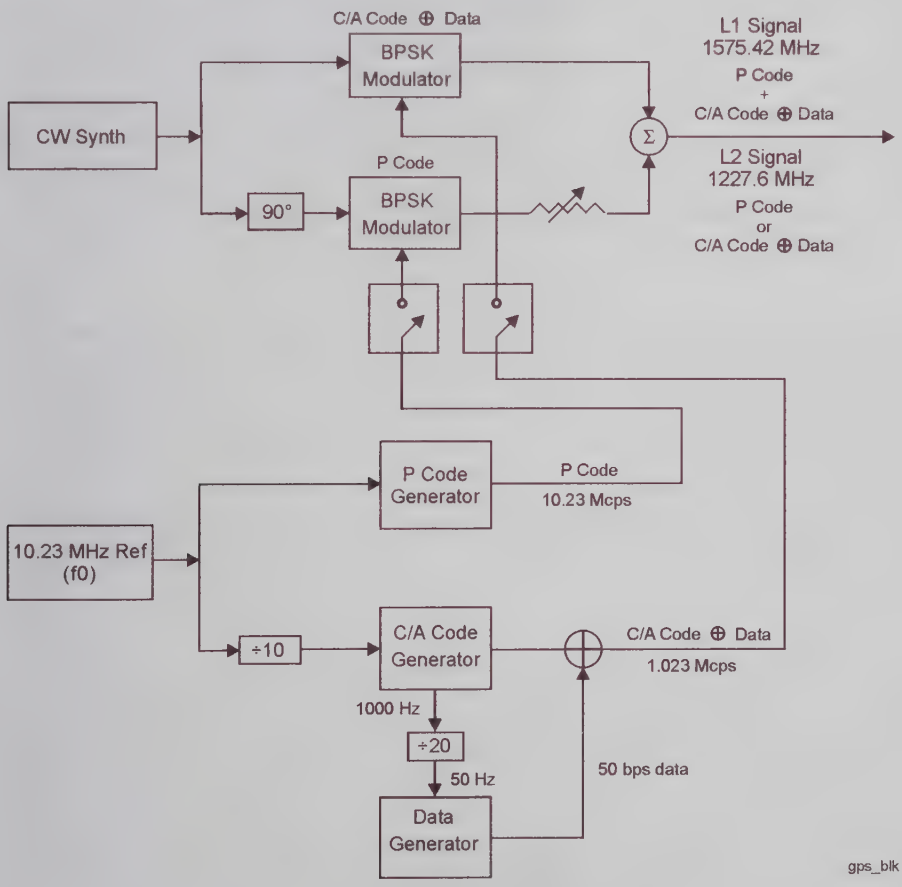
More advanced features are available for modifying the basic signal to match your testing needs. The following is a list of some of these features:

- P code power adjustment (–40 to 0 dB)
- adjustable chip clock reference (1 kcps to 12.5 Mcps)
- selectable I/Q phase
- selectable filters and the ability to create user-defined filters using the ESG features

Signal Generation Block Diagram

Figure 9-47 shows how the GPS signal is generated within the ESG. Notice that the C/A code is modulated onto the L-band signal using the I axis of the I/Q modulator, and the P code is modulated using the Q axis. The data provided by the data generator is selected by using the **Data** softkey or by choosing the TLM mode.

Figure 9-47 GPS Signal Generation Diagram



Data Modes and Subframe Structures

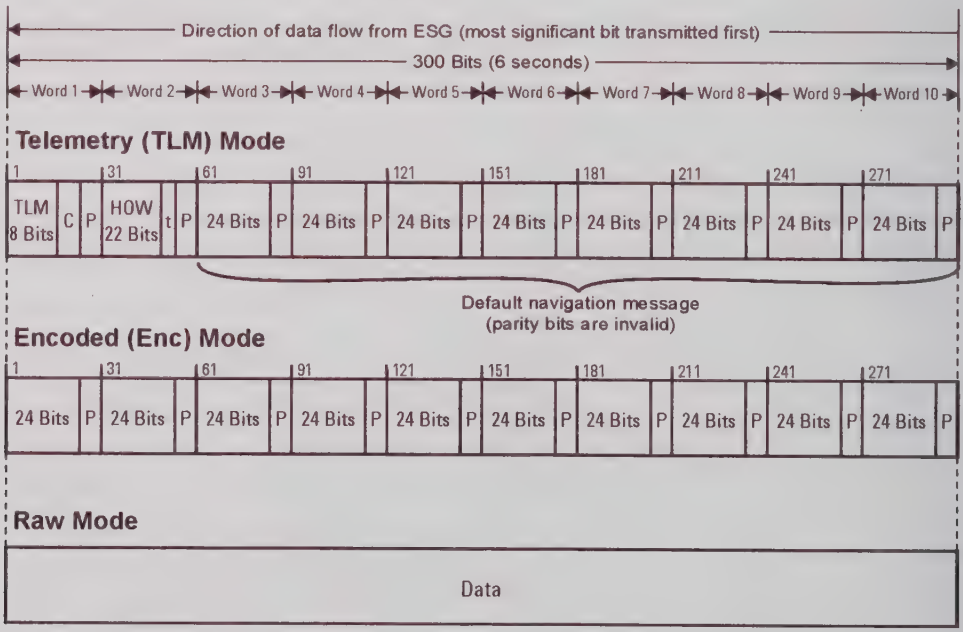
The GPS personality lets you transmit data three different ways using the C/A or C/A+P

ranging code selection:

- A raw (Raw) data mode which enables the continuous transmission of 300 bits of data per subframe without incorporating parity bits. This is well suited for BER and low-level demodulation testing.
- An encoded (Enc) data mode which enables the continuous transmission of 10 words (30-bits each) per subframe, with each word containing 24 bits of raw data along with 6 trailing parity bits computed from the selected data by the ESG.
- The telemetry (TLM) mode which enables the continuous transmission of a formatted TLM and handover word (HOW) along with default navigation data as outlined in the *GLOBAL POSITIONING SYSTEM STANDARD POSITIONING SERVICE SIGNAL SPECIFICATION*, 2nd Edition, June 2, 1995. This is a good mode for testing receiver functionality. For example, the C/No can be determined by testing the sensitivity of the receiver accepting the data.

Figure 9-48 shows the subframe structures for each data mode.

Figure 9-48 Subframe Structures



C - TLM bits 9 through 24 are reserved
P - 6 parity bits per word
t - 2 noninformation bits used for parity computation

gps_df1

The TLM word, which is 30-bits long, is structured using the preamble for the first 8-bits, 16 reserve bits (9 through 24, all set to zero), and the 6 parity bits for bit locations 25 through 30.

The HOW also contains 30-bits where the first 17 represent the most significant bits (MSBs) for an incrementing time-of-week (TOW) count. Additionally, the HOW message contains the two bits (bits 23 and 24) used for parity computation along with the 6 parity bits.

During a GPS signal transmission, a pulse signal is generated every 6 seconds at the EVENT 1 rear panel connector. This pulse coincides with the beginning of each subframe starting with the second subframe. The pulse is synchronized to the RF output, which compensates for any internal signal delays.

Chip Clock Reference

The GPS reference clock (chip clock) has the advanced feature of being adjustable with a factory set value of 10.23 Mcps (the GPS standard). You also have the convenience of using the internal chip clock or having an external source provide the reference. When an external reference is used, it is applied to the DATA CLOCK input connector.

NOTE Whenever an external source is providing the chip clock reference, it is imperative that its frequency matches the value set with the **GPS Ref (f0)** softkey.

The P and C/A code chip rates are dependent on the value set using the **GPS Ref (f0)** softkey whether you are using the internal or an external chip clock reference. The P code chip rate matches the reference clock rate and the C/A code chip rate is one-tenth of the reference value (.1 x reference clock rate). Refer to Figure 9-47 on page 349 for a block diagram showing how the GPS signal is generated within the ESG.

User Files

Like the other data types, user files require a selection for the data mode (see "Data Modes and Subframe Structures" on page 349 for more information on data modes). User files are created either internally to the ESG or externally and downloaded, but file sizes are limited to the amount of available ESG memory. If files are created externally and contain a structure that incorporates parity bits, then the raw data mode should be used. This would enable the transmission of the file in its original form. Conversely, if your file did not have parity bits and you desired to have parity bits incorporated into the signal transmission, then you would select the encoded (Enc) data mode. This enables the ESG to compute the parity bits for the last 6-bits of each word.

NOTE If the encoded mode is selected with a user file that incorporates parity bits, the parity bits will be recomputed and their values changed.

Externally developed user files let you define signal structures that may not be available internally to the ESG. For example, if your needs require a fully coded signal consisting of frames structured according to the GPS standards (1 frame consisting of 5 subframes and 25 pages), this structure could be developed externally and downloaded into the ESG, making it available for use.

User files can be created and accepted by the ESG in either binary or bit format.

Bit Error Rate Test Measurements

Bit error rate test (BERT) measurements are accomplished using the ESG with Option UN7 (Baseband BERT) installed or a customer-supplied, external BER meter. The GPS signal can be configured using either a PN9 or PN15 sequence. The Raw data mode is used so parity bits are not computed for the subframe. If the encoded (Enc) mode was selected, 6 parity bits would be computed for every 24-bits of data. This would disrupt the PN sequence.

When BERT measurements are made using an externally supplied BER meter, the ESG provides the GPS signal to the UUT (unit under test) and the BER meter would compute the error results. If the ESG with Option UN7 is used, the ESG will provide the signal and make the BERT measurements. When the ESG is making the BERT measurement, it will accept a clock and gate signal from the UUT along with the data. If the UUT does not have the capability to provide a data clock signal, the ESG can provide a clock signal from the rear panel Aux I/O connector (refer to "13. AUX I/O Connector" on page 24 for information on this connector). When the clock signal from the ESG is used, a delay must be added to the signal that corresponds to UUT's processing time. For information on setting up BERT measurements refer to "Setting Up a GPS Bit Error Rate Test" on page 248, and for further information on BERT, refer to "Bit Error Rate Tester–Option UN7" on page 334.

10 Troubleshooting

If You Encounter a Problem

If the signal generator is not operating properly, refer to the proper section in this chapter for a possible solution. If you do not find a solution, refer to the service guide.

NOTE If the signal generator displays errors, always read the error message text by pressing **Utility** > **Error Info**.

Basic Signal Generator Operations

Cannot Turn Off Help Mode

1. Press Utility > Instrument Info/Help Mode
2. Press **Help Mode Single Cont** until Single is highlighted.

The signal generator has two help modes; single and continuous.

When you press **Help** in single mode (the factory preset condition), help text is provided for the next key you press. Pressing another key will exit the help mode and activate the key's function.

When you press **Help** in continuous mode, help text is provided for the next key you press and that key's function is also activated (except for **Preset**). You will stay in help mode until you press **Help** again or change to single mode.

No RF Output

Check the `RF ON/OFF` annunciator on the display. If it reads `RF OFF`, press RF On/Off to toggle the RF output on.

The Power Supply has Shut Down

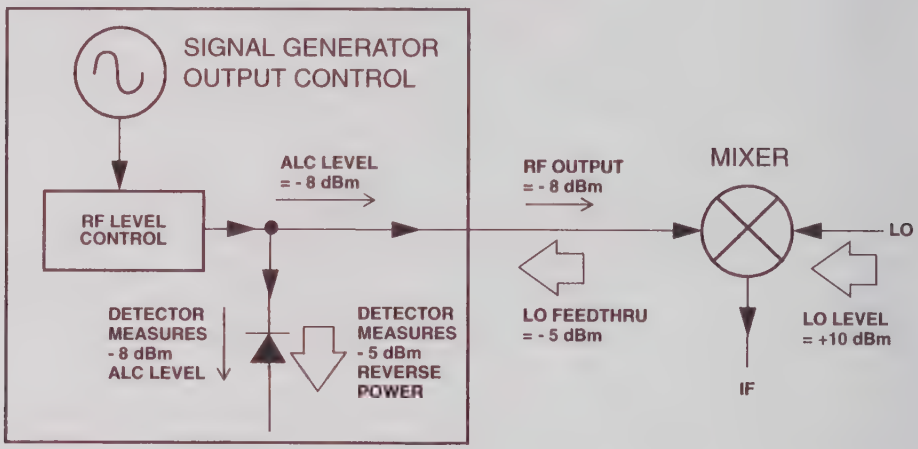
If the power supply is not working, it requires repair or replacement. There is no user-replaceable power supply fuse. Refer to the *Service Guide* for instructions.

Signal Loss While Working with Mixers

If you experience signal loss at the signal generator's RF output during low-amplitude coupled operation with a mixer, you can solve the problem by adding attenuation and increasing the RF output amplitude of the signal generator.

Figure 10-1 on page 356 shows a hypothetical configuration in which the signal generator provides a low amplitude signal to a mixer.

Figure 10-1 Effects of Reverse Power on ALC

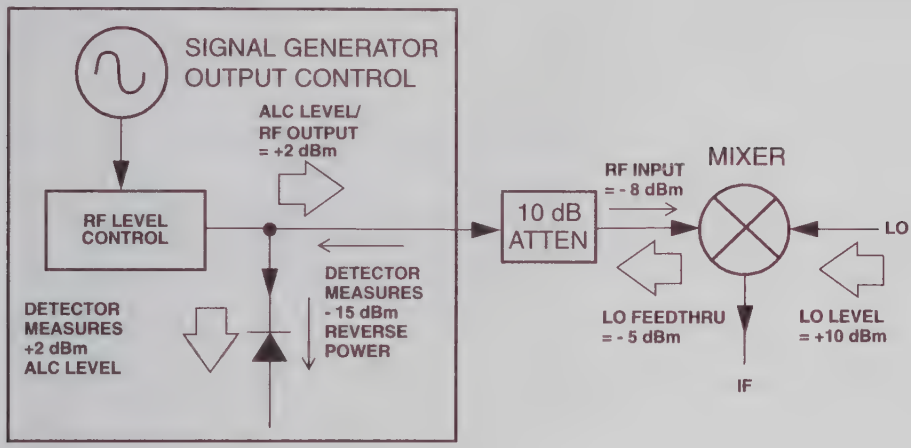


The internally leveled signal generator RF output (and ALC level) is -8 dBm. The mixer is driven with an LO of +10 dBm and has an LO-to-RF isolation of 15 dB. The resulting LO feedthrough of -5 dBm enters the signal generator's RF output connector and arrives at the internal detector.

Depending on frequency, it is possible for most of this LO feedthrough energy to enter the detector. Since the detector responds to its total input power regardless of frequency, this excess energy causes the ALC to reduce the RF output of the signal generator. In this example, the reverse power across the detector is actually greater than the ALC level, which may result in loss of signal at the RF output.

Figure 10-2 on page 357 shows a similar configuration with the addition of a 10 dB attenuator connected between the RF output of the signal generator and the input of the mixer. The signal generator's ALC level is increased to +2 dBm and transmitted through a 10 dB attenuator to achieve the required -8 dBm amplitude at the mixer input.

Figure 10-2 Reverse Power Solution



Compared to the original configuration, the ALC level is 10 dB higher while the attenuator reduces the LO feedthrough (and the RF output of the signal generator) by 10 dB. Using the attenuated configuration, the detector is exposed to a +2 dBm desired signal versus the -15 dBm undesired LO feedthrough. This 17 dB difference between desired and undesired energy results in a maximum 0.1 dB shift in the signal generator's RF output level.

Signal Loss While Working with Spectrum Analyzers

The effects of reverse power can cause problems with the signal generator's RF output when the signal generator is used with a spectrum analyzer that does not have preselection capability.

Some spectrum analyzers have as much as +5 dBm LO feedthrough at their RF input port at some frequencies. If the frequency difference between the LO feedthrough and the RF carrier is less than the ALC bandwidth, the LO's reverse power can cause amplitude modulation of the signal generator's RF output. The rate of the undesired AM equals the difference in frequency between the spectrum analyzer's LO feedthrough and the RF carrier of the signal generator.

Reverse power problems can be solved by using one of two unleveled operating modes: ALC off or power search.

ALC Off Mode

ALC off mode deactivates the automatic leveling circuitry prior to the signal generator's RF

output. In this mode, a power meter is required to measure the output of the signal generator and assist in achieving the required output power at the point of detection.

To set the signal generator to the ALC off mode, follow these steps:

1. Press **Preset**.
2. Press **Frequency**, enter the required frequency, and terminate the entry with the appropriate terminator softkey.
3. Press **Amplitude**, enter the required amplitude, and terminate the entry with the appropriate terminator softkey.
4. Press **RF On/Off**.
5. Press **Amplitude** > **ALC Off On**.

   This deactivates the signal generator's automatic leveling control.
6. Monitor the RF output amplitude as measured by the power meter.
7. Press **Amplitude** and adjust the signal generator's RF output amplitude until the desired power is measured by the power meter.

Power Search Mode

Power search mode executes a power search routine that temporarily activates the ALC, calibrates the power of the current RF output, and then disconnects the ALC circuitry.

To set the signal generator to manual fixed power search mode, follow these steps:

1. Press **Preset**.
2. Press **Frequency**, enter the required frequency, and terminate the entry with the appropriate terminator softkey.
3. Press **Amplitude**, enter the required amplitude, and terminate the entry with the appropriate terminator softkey.
4. Press **ALC Off On**.

   This deactivates the ALC circuitry.
5. Press **RF On/Off**.
6. Press **Do Power Search**.

   This executes the manual fixed power search routine.

There are two power search modes: manual and automatic.

When **Power Search Manual Auto** is set to Manual, pressing **Do Power Search** executes the power

search calibration routine for the current RF frequency and amplitude. In this mode, if there is a change in RF frequency or amplitude, you will need to press **Do Power Search** again.

When **Power Search Manual Auto** is set to Auto, the calibration routine is executed whenever the frequency or amplitude of the RF output is changed.

RF Output Power too Low

1. Look for an OFFS or REF indicator in the AMPLITUDE area of the display.

   OFFS tells you that an amplitude offset has been set. An amplitude offset changes the value shown in the AMPLITUDE area of the display but does not affect the output power. The amplitude displayed is equal to the current power output by the signal generator hardware plus the value for the offset.

   To eliminate the offset, press the following keys:

   Amplitude > **More (1 of 2)** > **Ampl Offset** > **0** > **dB**.

   REF tells you that the amplitude reference mode is activated. When this mode is on, the displayed amplitude value is *not* the output power level. It is the current power output by the signal generator hardware minus the reference value set by the **Ampl Ref Set** softkey.

   To exit the reference mode, follow these steps:

   a. Press **Amplitude** > **More (1 of 2)**.

   b. Press **Ampl Ref Off On** until Off is highlighted.

   You can then reset the output power to the desired level.

2. If you are using the signal generator with an external mixer, see "Signal Loss While Working with Mixers" on page 355.

3. If you are using the signal generator with a spectrum analyzer, see "Signal Loss While Working with Spectrum Analyzers" on page 357.

No Modulation at the RF Output

Check the MOD ON/OFF annunciator on the display. If it reads MOD OFF, press **Mod On/Off** to toggle the modulation on.

Although you can set up and enable various modulations, the RF carrier is modulated only when you have also set **Mod On/Off** to On.

For digital modulation, make sure that **I/Q Off On** is set to On.

Sweep Appears to be Stalled

The current status of the sweep is indicated as a shaded rectangle in the progress bar. You can observe the progress bar to determine if the sweep is progressing. If the sweep appears to have stalled, check the following:

- ❑ Have you turned on the sweep by pressing any of the following key sequences?

  Sweep/List > Sweep > Freq

  Sweep/List > Sweep > Ampl

  Sweep/List > Sweep > Freq & Ampl

- ❑ Is the sweep in continuous mode? If the sweep is in single mode, be sure that you have pressed the **Single Sweep** softkey at least once since completion of the prior sweep. Try setting the mode to continuous to determine if the missing single sweep is blocking the sweep.
- ❑ Is the signal generator receiving the appropriate sweep trigger? Try setting the **Sweep Trigger** softkey to Free Run to determine if a missing sweep trigger is blocking the sweep.
- ❑ Is the signal generator receiving the appropriate point trigger? Try setting the **Point Trigger** softey to Free Run to determine if a missing point trigger is blocking the sweep.
- ❑ Is the dwell time appropriate? Try setting the dwell time to one second to determine if the dwell time was set to a value which was too slow or too fast for you to see.
- ❑ Do you have at least two points in your step sweep or list sweep?

Cannot Turn Off Sweep Mode

Press **Sweep/List > Sweep > Off**.

In the sweep mode menu you can choose to set the sweep to various sweep types or to turn sweep off.

Incorrect List Sweep Dwell Time

If the signal generator does not dwell for the correct period of time at each sweep list point, follow these steps:

1. Press **Sweep/List > Configure List Sweep**.

   This displays the sweep list values.

2. Check the sweep list dwell values for accuracy.

3. Edit the dwell values if they are incorrect.

NOTE The effective dwell time at the RF OUTPUT connector is the sum of the value set for the dwell plus processing time, switching time, and settling time. This additional time added to the dwell is generally a few milliseconds. The TTL/CMOS output available at the TRIG OUT connector, however, is asserted high only during the actual dwell time.

If the list dwell values are correct, continue to the next step.

4. Observe if the **Dwell Type List Step** softkey is set to Step.

   When Step is selected, the signal generator will sweep the list points using the dwell time set for step sweep rather than the sweep list dwell values.

   To view the step sweep dwell time, follow these steps:

   a. Press **Configure Step Sweep**.

   b. Observe the value set for the **Step Dwell** softkey.

List Sweep Information is Missing from a Recalled Register

List sweep information is not stored as part of the instrument state in an instrument state register. Only the current list sweep is available to the signal generator. List sweep data can be stored in the instrument catalog. For instructions, see "Storing Files" on page 50.

Data Storage

Registers With Previously Stored Instrument States are Empty

The save/recall registers are backed-up by a battery when line power to the signal generator is not connected. The battery may need to be replaced.

To verify that the battery has failed, follow these steps:

1. Turn off line power to the signal generator.
2. Unplug the signal generator from line power.
3. Plug in the signal generator.
4. Turn on the signal generator.
5. Observe the display for error messages.

If either error message –311 or –700 is stored in the error message queue, the signal generator's battery has failed.

6. Refer to the Service Guide for battery replacement instructions.

Saved an Instrument State in a Register but the Register is Empty or Contains the Wrong State

If you have selected a register number that is greater than 99, the signal generator will automatically select register 99 to save your instrument state.

If the register number you intended to use is empty or contains the wrong instrument state, press the following keys:

Recall > **99** > **Enter**.

This recalls register 99. The lost instrument state may be saved there.

Signal Generator Lock-Up

If the signal generator is locked up, check the following:

- Make sure that the signal generator is not in remote mode. (In remote mode, the R annunciator will appear on the display.) Press **Local** to exit remote mode and unlock the front panel keypad.
- Make sure that the signal generator is not in local lockout condition. Local lockout will prevent front panel operation of the signal generator. For more information on local lockout, refer to the Programming Guide.
- Check for a progress bar on the signal generator display which indicates that an operation is in progress.
- Press **Preset**.
- Cycle power on the signal generator.

Fail-Safe Recovery Sequence

The fail-safe recovery sequence should only be used if the previous suggestions do not resolve the problem.

NOTE This process will reset the signal generator, but it will destroy data.

The fail-safe recovery sequence will destroy the following types of data:

- all user files (instrument state and data files)
- DCFM/DCΦM calibration data
- persistent states

Do not attempt to perform any other front panel or remote operations during the fail-safe sequence.

To run the fail-safe sequence, follow these steps:

1. Hold down the **Preset** key while cycling power.

2. Continue to hold down the **Preset** key until the following message is displayed:

WARNING **You are entering the diagnostics menu which can cause unpredictable instrument behavior. Are you sure you want to continue?**

CAUTION Carefully read the entire message! It may list additional risks with this procedure.

3. Release the **Preset** key.
4. Press **Continue** to continue with the sequence (or **Abort** to abort with no lost files).

At the conclusion of the sequence, follow these steps:

1. Cycle power.

   Cycling power restores all previously installed options. You should expect to see several error messages resulting from calibration files being restored from EEPROM.

2. Perform the DCFM/DCΦM calibration.

   Refer to the **DCFM/DCΦM Cal** softkey description in the Key and Data Field Reference Volume 1.

3. Agilent Technologies is interested in the circumstances that made it necessary for you to initiate this procedure. Please contact us at the appropriate telephone number listed in Table 10-1 on page 366. We would like to help you eliminate any repeat occurrences.

Upgrading Firmware

The firmware in your signal generator may be upgraded when new firmware is released. New firmware releases may contain signal generator features and functionality not available in previous firmware releases.

To inquire about the availability of new signal generator firmware, contact Agilent at `http://www.agilent.com/find/upgradeassistant`, or call the appropriate number listed in Table 10-1 on page 366.

Returning a Signal Generator to Agilent Technologies

To return your signal generator to Agilent Technologies, follow these steps:

1. Be prepared to give your service representative as much information as possible regarding the signal generator's problem.
2. Call the phone number listed in Table 10-1 appropriate to the signal generator's location. After sharing information regarding the signal generator and its condition, you will receive information regarding where to ship your instrument for repair.
3. Ship the signal generator in the original factory packaging materials, if they are available. If not, use similar packaging to properly protect the instrument.

Table 10-1 Contacting Agilent

Online assistance: www.agilent.com/find/assist

United States
(tel) 1 800 452 4844

Latin America
(tel) (305) 269 7500
(fax) (305) 269 7599

Canada
(tel) 1 877 894 4414
(fax) (905) 282-6495

Europe
(tel) (+31) 20 547 2323
(fax) (+31) 20 547 2390

New Zealand
(tel) 0 800 738 378
(fax) (+64) 4 495 8950

Japan
(tel) (+81) 426 56 7832
(fax) (+81) 426 56 7840

Australia
(tel) 1 800 629 485
(fax) (+61) 3 9210 5947

Asia Call Center Numbers

Country	Phone Number	Fax Number
Singapore	1-800-375-8100	(65) 836-0252
Malaysia	1-800-828-848	1-800-801664
Philippines	(632) 8426802 1-800-16510170 (PLDT Subscriber Only)	(632) 8426809 1-800-16510288 (PLDT Subscriber Only)
Thailand	(088) 226-008 (outside Bangkok) (662) 661-3999 (within Bangkok)	(66) 1-661-3714
Hong Kong	800-930-871	(852) 2506 9233
Taiwan	0800-047-866	(886) 2 25456723
People's Republic of China	800-810-0189 (preferred) 10800-650-0021	10800-650-0121

Asia Call Center Numbers

Country	Phone Number	Fax Number
India	1-600-11-2929	000-800-650-1101

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